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Approaches for Developing a Model for Information and Communication Technology (ICT) Implementation in the Higher Education Environment

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by

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We hereby certify that this dissertation, submitted by Thomas Kurtz, conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.

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An Abstract of a Dissertation Submitted to Nova Southeastern University
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This dissertation investigates approaches for the development of an implementation model for ICT systems in the higher education environment. ICT systems have been implemented in various education settings, but have been narrowly focused in nature. There lacks a generalizable model to implement these systems in higher education settings. The research questions in this study sought to identify the criteria that can be used to develop and evaluate the implementation model.

The design science research methodology selected for this study used product criteria defined in a literature review to guide the development of the model. An expert panel consisting of administrators, faculty and technology implementers was then used to affirm the criteria that was used to develop the implementation model. A set of design characteristics based upon the results of the expert panel consensus resulted in the design of the implementation model. The model addressed approaches for implementation and measurement for each criterion in the study. The model was pre-evaluated by the expert panel.

The model was then post-evaluated by a new evaluation panel based upon its effectiveness in satisfying the criteria developed by the expert panel. The evaluation of the model for ICT implementation in higher education found that it appropriately met the specified design criteria established by the expert panel. Future research in the application of the implementation model and testing at another educational institution was suggested.

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Table of Contents

Appendices

List of Figures

List of Tables

Chapter 1

Introduction

Introduction

There has been an enthusiasm to use Information and Communication Technology (ICT) systems to support learning in the higher education environment. There lacked a model that appropriately addressed the implementation of ICT systems into generalized higher education settings (Caballe, Xhafa & Barolli, 2010; Huda & Hussin, 2013; Piki, 2010). The goal of the study was to develop an implementation model for ICT systems in higher education. Potential success measures for ICT system implementation assessment were created and then affirmed using a Delphi process for expert panel consensus. The results of this study led to a better understanding of ICT system implementation in the higher education environment by creating a model that can be applied across higher education disciplines and settings.

The following sections in this chapter identify the problem and outline the research goals and questions. The relevance and significance section describes the impact that this study has on ICT implementation in higher education. Barriers to completion will be introduced. Assumptions, limitations and delimitations of completing the study will be discussed. Finally, the definition of all key terms within the study will be presented.

Problem Statement

There has been a history of sub-optimal adaptation of ICT systems used in business, industry, and government when applied to higher education institutions. In addition, there was an identified lack of an understanding of how to effectively implement and evaluate ICT systems in higher educational settings (Caballe, Xhafa & Barolli, 2010; Huda & Hussin, 2013; Piki, 2010; Wagner et al., 2005). The higher education environment consists of faculty and student user populations, which differ from that of business and industry ICT implementations. Faculty and student user groups have differing characteristics regarding behavioral intention than those in business user groups which need to be accounted for in ICT system implementation strategies (Birch and Irvine, 2009). Implementation factors with pedagogical approaches and drivers for implementing ICT systems including educational industry changes and government policy drivers also differ from business and industry implementations (Huda & Hussin, 2013; Munoz-Repiso & Tejedor, 2012). No relationship exists between the sheer availability of ICT systems and student learning, although there is research that specific applications that focus on implementation and integration can show improvement in student learning (Wagner et al., 2005). While researchers have designed, implemented, and evaluated ICT systems in a variety of specific educational settings, the lack of generalized application and the inability to replicate the ICT implementation model in other settings had led to wasted resources and redundancy (Caballe, Xhafa & Barolli, 2010; Piki, 2010; Roschelle, Rosas & Nussbaum, 2005). In addition, evidence further indicates that lost educational opportunities occur in these implementations, again due to the lack of an effective implementation model (Roschelle, Rosas & Nussbaum, 2005; Valdivia & Nussbam, 2007).

From the perspective of educational leaders, technology has often been viewed as a “silver bullet” that can solve the problems in higher education in terms of performance and productivity (Meyer and Xu, 2009). For example, the use of technology-supported collaboration among students has been shown to improve student learning over that of a traditional face-to-face classroom environment (Zurita & Nussbaum, 2004; Valdivia & Nussbaum, 2007; Zurita, Baloian & Baytelman, 2008). Success criteria, including technology acceptance factors, administrative support, time availability, and teaching load have been used to direct implementations of ICT systems in targeted environments that focus on specific user groups or programs (Caballe, Xhafa, and Barolli, 2010; Lim, 2006). The aforementioned criteria enable development of widespread implementation strategies and measure the utility that these systems provide (Echeverria et al., 2011; Meyer & Xu, 2009; Zurita & Nussbaum, 2004). As an example of targeted implementations, Sumak, Polancic, and Hericko (2010) studied user acceptance of e-learning systems with a sample of technology-oriented students that introduced biases that controlled against resistance to use technology. It was determined that future studies should include a more widespread sample to eliminate biases that small focused groups can introduce. Despite the potential value that is provided by ICT systems in higher education, there lacked a model for widespread implementation (Caballe, Xhafa & Barolli, 2010; Sumak, Polancic, and Hericko, 2010). The development of an implementation model established a platform where ICT systems can be more successful in the unique higher education environment (Caballe, Xhafa & Barolli, 2010; Piki, 2010; Roschelle, Rosas & Nussbaum, 2005;).

Dissertation Goal

The goal of this study was to create an implementation model that addresses the lack of understanding of how to implement ICT systems across widespread higher education environments. Design-science research methods were used to create a model for implementation of ICT systems based upon the work of Hevner, March, Park, and Ram (2004). Design-science research was used for the creation and evaluation of an IT artifact to solve organizational problems. Ellis and Hafner (2006) and Zurita, Baloian, and Baytelman (2009) used design-science research to define criteria that a communication environment needed to meet to support collaborative learning and how those criteria can be used to evaluate the success of that system. In order to solve the lack of understanding on how to effectively implement and evaluate ICT systems in higher education, a model for widespread implementation was created following those essential design-science research questions and guidelines.

The design-science guidelines outline that the research must produce a viable artifact that provides a technology-based solution to a given relevant problem with significant impact and research contribution. Hevner et al. (2004) also noted that design-science research guidelines dictate the need to evaluate the designed artifact using well-executed evaluation methods. In order to create the model, success criteria identified in past implementation studies as well as data from an expert panel were used to create a set of potential success criteria for the model. The Delphi process for expert panel consensus was used to validate the criteria and evaluate the developed implementation model.

Research Questions

1. What criteria must an implementation model for incorporating ICT learning systems in higher education meet in order to be considered successful?
2. How can an implementation model for incorporating ICT learning systems in higher education be evaluated against those criteria?

Relevance and Significance

According to Wong and Li (2008), ICT systems play a role in reengineering educational delivery and student learning, but sometimes these systems are implemented in isolation instead of part of larger educational reform that is needed for ICT systems to be effective. ICT systems have moved beyond a pure teaching and learning aid to a movement of transforming education in the information society (Munoz-Repiso & Tejedor, 2012). Roschelle, Rosas, and Nussbaum (2005) stated that there is a potential for increases in student learning and collaboration using collaborative system environments and careful planning for implementation is of vital importance for success, but the research does not identify a process or model for implementing these systems. The sporadic and specialized nature of collaborative system implementation in education environments is further supported by the varying educational levels of targeted students in studies by Zurita and Nussbaum (2004), Fitzpatrick and Ali (2010) and Valdivia and

Nussbaum (2007). Collaborative system implementations are far reaching in implementation from elementary applications through post-secondary education and have been found to have a statistically significant improvement in student learning performance. Valdivia and Nussbaum (2007) found that regular use of collaborative learning systems improves academic performance, with the experimental group mean of 5.1 (SD 1.537) and the control group mean of 3.4 (1.361) on a standardized exam. Despite the value that ICT systems provide in the classroom there was no model that addressed the implementation of these systems into widespread higher educational settings (Caballe, Xhafa & Barolli, 2010; Sumak, Polancic, and Hericko, 2010).

Piki (2010) studied post implementation evaluation of collaborative technology, but was narrowly focused since Piki studied an implementation of ICT in business curriculum only. Piki noted that there were no longitudinal studies that appropriately assessed system implementation. The qualitative study identified factors that were used to assess implementation of collaborative technology. Research completed by Piki (2010) and Caballe, Xhafa, and Barolli (2010) identified that future research should investigate a generalized approach to collaborative system implementation and evaluation. Piki also noted that a qualitative assessment of mobile collaborative system implementation should be created. Wong and Li (2009) showed that assessment of ICT implementations have put too much focus upon only student performance instead of a holistic approach to measuring both a student perspective as well as the perceptions by teachers.

Barriers and Issues

The difficulties associated with the study related to the creation of an implementation process and assessment method that can be integrated into studies of varying application and content area. While there was support for the creation of a generalized implementation strategy, the creation of that model was strongly reliant upon the collection of data that will lead to potential criteria for success (Caballe, Xhafa, and Barolli, 2010; Hevner et al., 2004; Huda & Hussin, 2013).

The collection of data to establish the assessment criteria came from an extensive historical study to gather potential implementation success factors from past studies (Ellis & Levy, 2009). An expert panel of faculty, administrators, and implementers was also conducted to validate the assessment criteria (Yang & Lu, 2012). A significant amount of additional research was necessary to determine which success factors can be applied to generalized system implementation. The validation of the assessment criteria was also a significant factor in the creation of an implementation model for ICT systems (Hevner et al., 2004).

Assumptions, Limitations and Delimitations

The primary assumption for this study was that the expert panel participants were both willing and able to make appropriate decisions and suggestions for success metrics in ICT system implementation. The Delphi technique used in this study built consensus among experts in ICT system use in higher education. This group consensus contributed to the creation of the measures used to assess system implementation success. Being a volunteer group, willingness of the participants on the panel was assumed. It was assumed that the expert panel participants were representative of higher education faculty, administration, and technology implementers. The ability of the panel to share knowledge and experience in ICT systems consistent with the normal population of higher education ICT users was also assumed.

Limitations of the study surrounded the voluntary participation in the study by the expert panel. The expert panel consisted of faculty, administrators, and implementers of technology. The faculty that participated in the study were drawn from instructors teaching a variety of program courses with a varied of teaching experience. Administrators and implementers were primarily full time staff. Participation in this study was be completely voluntary. All participants in the study were volunteers who may withdraw from the study at any time. The participants who finished the study may not, therefore, have been truly representative of the population.

Definition of Terms

Artifact: Construct, model, method or instantiation built to address unsolved problems in information systems research. Artifacts are built and evaluated through design-science research methodology (Hevner et al., 2004).

Collaborative Learning: Collaborative learning assists teaching through shared activity, using social interactions between participants (Zurita & Nussbaum, 2004). Collaborative learning is a means for participants to come to a mutually agreed upon view of a given problem.

Delphi Method: The Delphi method establishes consensus among expert panel participants using an iterative feedback process. Sequential questioning is used to gain consensus among expert participants with dispersed individuals (Chang et al., 2000; Clayton, 1997).

Design Science: The design science research methodology produces a new artifact that provides a technology-based solution to a relevant problem with significant impact and research contribution (Hevner et al., 2004). Design science research was developed based upon a set of guidelines that outline how a new artifact can appropriately solve a given complex research problem.

Efficacy: A belief of one's own capabilities to bring about desired outcomes (Sang et al., 2010).

Expert Panel: Group of participants that is brought together to share expert opinion for the collection, analysis, refining, and validation of critical information (Clayton, 1997).

Learning System: Information systems implemented for the improvement of student learning (Munoz-Repiso & Tejedor, 2012; Huda & Hussin, 2013).

Mobile Computer Supported Collaborative Learning (MCSCL): Collaborative learning systems delivered through mobile devices (Zurita & Nussbaum, 2004).

Mobile Device: Tablets, smart phones and other devices that are fully featured, but less of a form factor than traditional PCs or laptops (Murphy, 2011).

Model: A model is a set of constructs that represent a real-world situation based upon a research problem and its solution space (Hevner et al., 2004). A model must adequately represent the environment in which the research problem is set.

Product Criteria: The requirements that a designed artifact must meet in order to address a defined design-science research problem (Ellis & Levy, 2010).

Technology Acceptance Model (TAM): The theory that models how users accept and use technology, specifically perceived usefulness and perceived ease-of-use (Davis, 1989)

Uniform Theory of Acceptance and Use of Technology (UTAUT): A technology acceptance model developed to unify the many theories of acceptance and use of technology in information systems research (Venkatesh et al., 2003)

Summary

The problem addressed in this study was the history of sub-optimal adaptation of ICT systems used in business, industry, and government when applied to higher education institutions. In addition, there was a lack of an understanding of how to effectively implement and evaluate ICT systems in higher educational settings (Caballe, Xhafa & Barolli, 2010; Huda & Hussin, 2013; Piki, 2010; Wagner et al., 2005). While researchers have designed, implemented, and evaluated ICT systems in a variety of specific educational settings, the lack of generalized application and the inability to replicate the ICT implementation model in other settings led to wasted resources and redundancy (Caballe, Xhafa & Barolli, 2010; Piki, 2010; Roschelle, Rosas & Nussbaum, 2005).

The goal of this study was to create an implementation model that addressed the lack of understanding of how to implement ICT systems across widespread higher education environments. Design-science research methods were used to create a model for implementation of ICT systems based upon the work of Hevner, March, Park, and

Ram (2004). In order to solve the lack of understanding on how to effectively implement and evaluate ICT systems in higher education, a model for widespread implementation was created following those essential design-science research questions and guidelines.

The remaining chapters of this dissertation cover the review of the literature and the methodology for the study. Chapter two includes the review of the literature and is broken down into the core constructs that contribute to the problem including prior ICT system implementations in higher education, mobile collaborative learning systems, challenges in implementing ICT, measurement of implementation success, and education as a special case environment to study ICT system implementation. Chapter three outlines the methodology to be used in the study, including the research questions, participants, and procedures to be used.

Chapter four of this study identifies the results of the research, including the creation of the implementation criteria, implementation model, and expert panel pre- and post- evaluation of the model. Chapter five outlines the conclusions of the study, including the limitations and suggestions for future research.

Chapter 2

Review of the Literature

Introduction

This literature review will focus on the five key areas related to ICT implementation in higher education including: prior ICT implementation in higher education, mobile collaborative ICT systems, challenges in implementing ICT systems, measurement of implementation success, and education as a special case environment. In addition, the review will identify the components that contribute to the goals driving this research: developing an approach for implementing ICT systems into higher education by identifying the sub-optimal adaptation of these systems that exist in the education environment. Finally, the literature also will also clarify that there is a lack of understanding on how to effectively evaluate and measure these systems in order to gauge implementation success.

While there have been many studies into ICT system implementation in education, there is a lack of literature that is generalizable enough to be applied throughout the higher education environment. Research into prior ICT implementations in higher education shows that the studies have been specialized in nature, which does not lead to the ability to generalize the approaches to apply into other higher education settings.

There are several examples of ICT systems that have been implemented in education environments. One of the most common implementations is a mobile ICT system designed to facilitate collaborative learning in the classroom from student to student and student to faculty. However, mobile collaborative ICT system implementations in higher education are in their infancy (Caballe, Xhafa, and Barolli, 2010). The necessity of an implementation model for implementing mobile collaborative ICT systems is introduced in this section. This is the lab setting to be used for this study in which to test approaches for ICT system implementation in higher education. Research in this area has been completed in the past, but again, the implementations are largely specialized and lack a generalizable approach for widespread use.

As with any technology implementation, there are challenges that need to be addressed in order to properly implement ICT systems in any environment. The challenges in the ICT system implementation section describe the challenges that are experienced in education settings. The literature shows that careful planning and preparation is necessary to address the challenges of using technology in education environments.

As the goal of the study was to create an implementation model for ICT systems in education, the methods to evaluate and measure implementation success are introduced. Past studies that have measured implementation success are discussed to provide a set of characteristics or attributes that can be used to test the proposed implementation approach. Lastly, the unique characteristics of the users and environment within higher education are discussed in order to identify what separates the education environment from that of business and industry. The literature presented in this review establishes the problem of creating an approach for implementing ICT systems in higher education settings.

Prior ICT Learning System Implementation in Higher Education

While ICT systems have been shown to improve student learning, there is a lack of a framework to implement these systems (Munoz-Repiso & Tejedor, 2012; Huda & Hussin, 2013). The implementations of ICT systems have been sporadic and specialized in nature focusing on small, targeted areas or unique samples of users (Caballe, Xhafa, & Barolli, 2010; Roig-Torres, Xhafa, & Caballe, 2012). The implementations lack a holistic framework to account for the uniqueness of the characteristics of the education environment (Souleles, Savva, Watters, Annesley, & Bull, 2014). Future work needs to be done in order to create a more holistic approach to ICT system implementation in education (Caballe et al., 2010; Murphy, 2011).

Caballe et al. (2010) studied mobile ICT systems through a literature review of implementations. This meta-study established that mobile collaborative learning research was still in its infancy and identified several challenges and holes in the research into system implementation. The challenges identified in Caballe et al. revolved around the technology available in mobile devices, the implementation and acceptance of these systems by educators, and the evaluation of system implementations for both users and implementers. The limitations of the technology used in mobile devices, such as screen size, data entry, limited processing power, and battery life, were identified as an implementation challenge. Challenges in the implementation of mobile ICT systems by educators revolved around the change in pedagogical practices by faculty in the classroom. The resources provided by these systems were shown to contribute to informal learning, especially for adult learners. A lack of a comprehensive framework of broad based ICT studies was identified in the literature review to be a limitation in the body of knowledge. The research in mobile ICT systems was largely focused on specialized implementations without the ability to generalize to more broad based learning scenarios. This revealed that there is not enough experience or standardized evaluation in mobile ICT system implementations. In addition, it pointed to instructors as the integrators who must adapt to the change of educational delivery, overcome the technical limitations of the mobile devices, and overcome the feeling of intrusion in the ubiquitous mobile device environment.

Roig-Torres et al. (2012) expanded upon the research in Caballe et al. (2010), identifying that application of mobile devices into education is still in its infancy in comparison to research in business and industry sectors. Using a case study approach, a software system was created to support collaborative learning groups at the Open University of Catalonia. Roig-Torres et al. proposed an application designed to account for the limited screen size of mobile devices and present information appropriately for mobile device capabilities. The study showed that the addition of mobility into collaborative learning systems provides additional ability to enhance learning in educational environments. One of the implementation concerns noted in the study identified technology challenges related to the interface and screen size of mobile devices. There have been studies and guidelines for interface design, but these guidelines are not applicable in all cases and must be applied in specific context in order to work. The interface was designed around two identified fundamental contexts that include mobile technology and functional student group usage. The study was primarily focused on the design and development of the system to account for the technological challenges identified in the literature review. The result of the research was an example system to support learning groups with mobile devices. Future research areas identified the necessity to continue the line of research to implement and test the proposed system in an academic environment, which directly supports the goals identified in Chapter One.

Souleles et al. (2014), also building upon the search in Caballe et al. (2010), stated that there was a lack of studies into using mobile devices, iPads specifically, which could be applied to generalized higher education settings. The studies that existed did not have a pedagogical focus, which is necessary to capture the uniqueness of the higher education environment when implementing ICT systems. Although there was considerable potential to enhance learning, there was a noticeable shortage of studies on the use of tablets in higher education. Because of the noticeable gap in research on the instructional potential of these devices, Souleles et al. studied the implementation of iPad devices into art and design classes at Cyprus University. The study focused on a design based upon the students' perception of educational impact of using mobile devices. The phenomenographic study, a qualitative approach that focuses on a finite number of variations of experience with a phenomenon, was used in order to illustrate the variation within student perception. This methodology was used with the goal of a bottom up approach to identify the potential improvement for student learning using iPads in art and design curriculum. A total of 40 students were issued iPad devices and surveyed on their perceptions of learning improvement. The survey results found that student users were polarized, some finding the use of the iPads as value added, and others finding the iPads had no value added benefit to student learning. The results of the study showed that integrating the iPad into education does not enhance learning for all students. The perception of student learning improvement was purely due to the inherit capabilities of the device, not based on any curricular improvements integrated with iPad use. This study only added the ability for students to use iPads without a focused approach for integration into the curriculum. This approach has been shown to be unsuccessful and a prescriptive implementation strategy is necessary in order to achieve gains in student learning (Alvarez, Alarcon & Nussbaum, 2011; Caballe et al., 2010; Meyer & Xu, 2009; Piki, 2010).

Murphy (2011) stated that mobile device adoption studies in higher education were primarily pilot study focused and thus lacked a long-term approach for ICT integration in higher education. Murphy explored the use of post-PC devices as worldwide sales trends identified the increased presence of these devices in higher education. Murphy performed a brief literature review of studies in mobile device technology. The literature review showed that many other studies focused on the technology specifically, not on the application or implementation of that technology into education as a special use environment. Murphy's study focused more on the ability of these devices to facilitate teaching and learning in the education sector. The study surveyed 36 educational institutions on the use of post-PC devices in six specific areas including ubiquitous course access, enrollment and administration, collaboration, content generation, research, and productivity enhancement. Post-PC devices were defined in the study as tablets, smart phones, and other devices that are fully featured, but less of a form factor than traditional PCs or laptops. The results of the survey showed that 80.5% of the surveyed institutions had some implementation of post-PC devices. By far, the highest usage was in ubiquitous course access (83% of the institutions). The survey also showed that 33% of the institutions used the devices for content generation and 25% for student and instructor collaboration. The institutions used the devices in varying ranges from a deliberate, all-encompassing implementation throughout a student's educational experience to institutions that merely had the technology available with no intentional implementation focus. Regardless of the intention and depth of the implementation, Murphy noted that most uses were considered pilots with no significant m-learning strategy that can be generally applied to varying settings. There was only one institution that had a strategic focus on using the devices for mobile learning. Murphy noted that a limitation of the study is the dynamic and ever changing landscape of mobile device usage in higher education. The study identified that future research was needed into the study of mobile device usage from a curricular design and implementation focus.

With a focus on students instead of instructors, Munoz-Repiso and Tejedor (2012) performed a statistical analysis to determine the impact of ICT systems on academic performance of college students in Mexico and Spain. The sample included 1194 students in 40 subject areas at multiple colleges and universities. The age of participants ranged from 19-24 with 60% being female. The authors found that the teaching conditions that a student received ($t=3.97$, $p=.01$), the competence of managing ICT systems for teaching ($t=5.08$, $p=.01$), and the appraisal of ICTs as learning tools ($t=4.58$, $p=.01$) all had a strong correlation with above average results with the student population. The results show that students that express satisfaction with the teaching environment and use the support that the ICT system provides have the highest level of academic performance. Students in general had positive attitudes toward the use of ICT systems and the attitudes were slightly more positive with those having high achievement. In addition, the students also found value in the ICT system being used in the classroom and were very confident in the use of ICT systems. The confidence level was particularly high with students with high academic performance.

To further the research on implementation strategies, Huda and Hussin (2013) created a conceptual framework for evaluation of implementation effectiveness of IT systems in higher education institutions. They discovered that there was a thread of research in implementing new innovations in general, but there had yet to be a focus on higher education environments. Thus, the authors created a framework based on past IT implementations and adapted the implementations to work in the higher education environment. The literature review identified two dependent variables and six independent variables. Independent variables of managerial practice, learning orientation, human resources availability, climate, policies, and management support were studied to determine the impact on the dependent variables of implementation effectiveness and innovation implementation. The theoretical model was established based upon the historical study of several implementation models in other education environments and created a testable model for measuring effectiveness of ICT systems in higher education. However, the model was not implemented and tested. It was determined that future research is needed to test and validate the model. The study also showed that there was a need for future research in IT implementation in higher education settings. Huda and Hussin stated that the key barrier between innovation and system adoption is the implementation strategy.

Prior studies in ICT implementation have revealed that there is a need to further explore implementation strategies and models in higher education. Caballe et al. (2010) and Roig-Torres et al. (2012) demonstrated that ICT implementations, primarily in the mobile device realm, have been sporadic in nature and widespread implementation strategies was a needed future research thread. Munoz-Repiso and Tejedor (2012) studied academic performance improvements based upon ICT implementations, but failed to address implementation strategies that can be replicated throughout higher education. The research focused only on studying already implemented ICT systems compared to classrooms where ICT systems were not already implemented. Huda and Hussin (2013) showed a thread of research that moves toward an implementation strategy for higher education, but failed to test the theoretical model they created through their historical analysis. An effective model for implementing ICT systems in higher education is still necessary (Murphy, 2011).

Mobile Collaborative Learning ICT Systems

Mobile collaborative learning ICT systems have been shown to improve student learning when added as support to traditional learning environments (Zurita & Nussbaum, 2004; Valdivia & Nussbaum, 2007). However, several studies in mobile collaborative learning have shown that more research is necessary to integrate the systems with pedagogical practices and an intentional focus to train teachers to use the systems (Zurita et al., 2008; Alvarez et al., 2011). The research in this section shows the necessity for future research to appropriately implement mobile ICT systems in the education environment.

The addition of mobility can add value and positive impact on collaborative learning. MCSCL environments, as defined by Zurita and Nussbaum (2004), were shown to improve collaborative learning by leveraging mobile devices to support communication and collaboration among learners. This experimental field study observed 48 elementary school students in Chile working collaboratively on language studies, with and without the use of a MCSCL system with wirelessly connected PDAs, in order to identify the weaknesses in face-to-face collaborative settings. The system allowed students to communicate face to face or through the software system, which enabled them to collaborate with all students in the classroom, not just those at their table. The results of the categorical analysis of interviews and observations concluded that there were several problems with student collaboration without the use of technology including coordination, communication, organization, negotiation, synchronization, interactivity and mobility. A MCSCL system was developed using wirelessly connected PDA devices to focus on the weaknesses in communication, organization, interactivity and mobility identified in the first observations. The same educational activity was assigned to a new set of students using the MCSCL system, and data was again collected through videotaped interviews and observations of the students. Zurita and Nussbaum concluded that the dependent variable, usability, was improved by the implementation of the MCSCL system by overcoming the weaknesses of face-to-face interactions and collaboration that were identified in the first part of the study.

Valdivia and Nussbaum (2007) performed an experimental study on 40 undergraduate computer engineering students using a wireless mobile collaborative learning system. The hypothesis in this study was that use of the system would improve student performance and student interest in the course. The student population was separated into two separate sections of 20 students, with the wireless system was deployed in an experimental group, while the other section remained in a traditional control group. Student performance on the first standardized exam was improved from the control group (M=4.5, SD = 0.857) and the experimental group (M=5.0, SD=1.048). Student performance on the second exam also improved from the control group (M=3.4, SD=1.361) and the experimental group (M=5.1, SD=1.537). T-tests established that the difference between the control and experimental group was statistically significant ($t(40)=3.5332$, $p = 0.0015$). The answers to the open questions in the survey showed increased communication between peers as well as an increased perception of student to professor communication while using the mobile device system.

Zurita et al. (2008) used a mobile collaborative learning environment, called MCI-Supporter, to address pedagogical practices and interaction between students and teachers in a classroom. The implementation used handheld PDAs for the students and tablet PCs for the instructors. The software design was used to improve the pedagogical practices introduced in the literature review which included problem based learning, assessment, coaching, reflection, feedback, challenge based learning, peer assisted learning, and mobile collaborative learning. Twenty-four students and two instructors participated in the experimental study. The study was preliminary in nature in order to test the software design before performing a large-scale formal test. The initial study surveyed the student participants on the effectiveness and usability of the system. The survey results showed that 67% of the students agreed, and 33% strongly agreed that the system was easy to learn and use. When questioned on whether the system was an effective support system for social interaction, 66.6% agreed, 16.6% strongly agreed and 16.6% felt neutral. All students suggested that the system made them more motivated to participate in their own learning with the use of the system. The increased mobility enabled the students to have better quality interactions with the instructor and other students by simultaneously using the system while participating in face-to-face interaction. Both instructors identified that the system could be implemented with any type of content. The preliminary study led the authors to recommended subtle software changes for a longer-term study with a larger student sample.

Alvarez et al. (2011) described mobile devices as being potential tools for increased student learning, but also identified a need to have a solid framework for the systems to serve defined purposes. The study pointed out that educational studies do exist that support the potential for incorporating mobile devices in the classroom, but educational tools are needed that are practical and meet the needs of instructors and learners. Citing mobile device research, including Roschelle et al. (2010), Zurita and Nussbaum (2007), and Zurita and Nussbaum (2004), the authors reviewed the various studies that had been performed that show the potential benefits to incorporating mobile devices into educational settings. Alvarez et al. proposed a pedagogical model for facilitating the implementation of collaborative learning environments into the classroom. The study primarily focused on the implementation of a software application that integrated mobile devices with a learning management system. The software was designed to facilitate student collaboration with the teacher as a guide in face-to-face learning situations. The study focused on both a one-month K-12 setting and a one-semester higher education implementation, each with 20-25 students. The evaluation of the software was done in prior work (Nussbaum et al., 2009) and was not part of this work. This qualitative study gauged the effectiveness of the software by evaluating the perception of improvement in collaboration by the participation of students in the electronic format. The study lacked an encompassing implementation method that can be applied throughout all ICT systems within higher education. Although this study identified that a design methodology was used to create the software model for use with mobile collaborative ICT systems, there were many elements that were not discussed. One element that was not addressed was instructor experience or training with technology. The instructors used in the system already had exposure to the software and even helped develop the software for a prior study. Student satisfaction with the system was based only upon a qualitative survey and student participation within the system. No formal methodology was used in order to appropriately evaluate the implementation of the system.

The potential value that mobile collaborative ICT systems provide to student learning has been mitigated by the lack of appropriate implementation strategies that can leverage that value throughout widespread higher education use. Zurita and Nussbaum (2004) and Valdivia and Nussbaum (2007) have shown the potential value that these systems can provide. The need for future research to appropriately implement mobile collaborative learning systems in education has been shown by Zurita et al. (2008) and Alvarez, et al. (2011).

Challenges in Implementing ICT

Mobile devices have widespread use within learning environments and have the ability to enhance student learning in the classroom as shown in the last section, but there are many challenges that are native to the mobile platform (Echeverria et al., 2011; Motiwalla, 2007; Chung, Kuo & Liu, 2010). Tablet PC devices also have been shown to be challenging and engagement with the devices can decrease over time (Toto et al., 2008). The integration of any technology into the classroom environment has been shown to also introduce a challenge for faculty and administrators to mitigate the distraction the technology can introduce into the classroom (Thomas, O'Bannon & Bolton, 2013). The challenges with technology use, student engagement, and focus all contribute to the challenges faced when implementing an ICT system.

Echeverria et al. (2011) explored the implementation of collaborative learning systems using mobile phones instead of using more full featured devices such as PDAs or tablet PCs to respond to the proliferation of mobile phones among students. The research investigated usability of less expensive and less robust devices to support collaborative learning. The research used a pre-developed system called Activity Framework by Echeverria et al. (2006) to explore face-to-face collaboration among ninth grade physics students supplemented with the use of mobile phone devices. A survey tool was used to determine the students' familiarity with the devices, their impression of usability and efficiency of the system as well as their overall satisfaction with the system. Qualitative measures were used to gauge student comfort with the technology. Prior to the study, 73.53% of students had frequently used cell phone devices before their exposure to the system. When compared with the original implementation of the system using PDAs (90.08% efficient), the students were less efficient in answering the questions in the timed format using cell phones where only 78.53% of the questions were answered. The percentage of questions answered correctly was consistent between the two technologies. In terms of satisfaction, 81.82% of the students said the system was enjoyable to use, but 32.35% of the students found the cell phone interface to be frustrating. Qualitatively, the authors found that the students were very comfortable using the devices prior to the study, and noted that future studies should be conducted with different types of participants to take into account the challenges of usability when participants are less familiar with technology. Limitations in the study included the design of an ICT system with the limited resources provided by mobile phones and user interfacing with the small form factor of the devices. Age, type of user, and different applications were noted to be potential future paths of research in order to determine usability and satisfaction of mobile collaborative learning. Echeverria et al. identified that future research in comparing less robust devices to PDAs and other devices in the same study was necessary to more fully understand technology challenges in mobile collaborative learning systems.

Thomas, O'Bannon and Bolton (2013) surveyed teachers to determine the barriers and challenges that hurt perception of usefulness of cell phones in the classroom. The literature review in Thomas et al. showed that there are many advantages associated with the features of these devices, including cameras, audio and video capture, Internet access, and collaborative features. Though there are many advantages, those are moderated by misuse, interruption of normal classroom activity, concerns of using the devices for cheating, and the lower percentage of cell phone owners in the secondary education area. This distraction was also shown as a design challenge for schools to manage disruption of traditional classes in Sharples and Roschelle (2010). Other areas that were identified in the literature review that prohibited appropriate use of mobile technology included a lack of faculty training and time to plan for integration of the devices into the educational activities. The study also noted that faculty attitudes toward using mobile devices for teaching was improving. The study surveyed 79 classroom teachers and found that many

(70.5%) of the respondents were in favor of using cell phones in the classroom, but identified many barriers to their use. Many participants (72%) stated that communication with staff, faculty, and students was done through mobile devices, but only few (7.7%) used mobile devices for assigned classwork. A majority (59%) of the teachers identified that mobile devices could increase student engagement. The faculty identified many challenges, including a lack of access to devices was a barrier for use in education (61.5%), mobile devices were seen as classroom distraction (51%) and mobile devices attributed to poorer writing skills (25.6%). Practical implications were identified as barriers for classroom use by a majority of the teachers (70.5%). While this study is purely a survey of instructor opinion, it supports the need to design mobile device use in education in such a way that mitigates the concerns expressed by faculty. These challenges should be cautiously considered during any ICT system implementation.

Showing the growth in device usage, Motiwalla (2007) studied the extension of wireless handheld devices, which have been commonly used in industry, into applications of e-learning. Motiwalla showed through the literature review that use of ICT systems in education is only effective when the developers and implementers understand the strengths and weaknesses of the technology and integrate the strengths into pedagogical practices while minimizing the inherent challenges of the device. To address that issue, Motiwalla created a framework for mobile technology application within the classroom that consists of mobile connectivity and e-learning pedagogical practices. The benefits of mobile devices found in the study were plentiful, including collaborative tools, ubiquitous connectivity, and access to information that leads to better decision making. Challenges with using mobile devices surrounded the screen size, lower processing power, reliability, and security concerns. Creating a system that was optimized for the small screen and data input on the mobile devices was intended to mitigate the challenges with the technology. The system also connected to PC systems so true interoperability was created. A sample of 19 undergraduate students were used in the study. Based upon a five-point Likert scale, students found that the system was useful (3.89) and a good complimentary tool to the traditional class environment (3.58). The students also felt that the tool was an easy way to communicate with students (3.42) and instructors (3.32). Students were neutral on ease of use (2.68). Most students in the study noted that the mobile keypad and screens were difficult to navigate and enter data. Longitudinally, student perception of ease of use increased once students were more familiar with the system.

In a second study, Motiwala (2007) surveyed 44 students with modified questions that related not just to the m-learning system but also the use of mobile devices in general. The second survey resulted in a high level of students seeing the system as a learning tool (4.22), providing a flexible access ability (4.27) and convenient to use (4.05). In the second survey, students also commented on the small screen size and tedious process of entering data. It was noted that with the limited screen and input, students may spend more time looking for the information than actually reading it. The authors stated that the promise of m-learning is abundant, but will not happen over night. It was noted that careful planning to make the most use out of the technology and planning for the challenges inherit to the technology was vitally important.

Chung, Kuo and Liu (2010) applied research that showed that collaborative inquiry can be used as an effective means for scientific inquiry. They noted that prior studies in mobile collaborative learning systems starting with Zurita and Nussbaum (2004) indicated that PDAs have become an affordable way to implement these systems in the classroom. Chung et al. explored the application of handheld devices in science courses with 56 freshmen in a physics class at National Central University in Taiwan. Their research focused on group regulation using computer supported collaborative learning and how it leads to meaningful learning by working through peer interaction specifically focusing on when students in the collaborative groups did not agree on an answer, and how it was resolved.

A model of student interaction was created from the observed student behaviors and instructor evaluations. The model established four areas of student involvement: concurrent informed cooperative exploration; sequential informed cooperative exploration; concurrent concealed exploration; and no interaction. Each area achieved a level of student agreement and conflict and the potential student performance varied with each type of interaction. Instructors noted that the highest performing students fell into the concurrent informed cooperative exploration category and spent the most time using the system. The students with no interaction with the system performed at the lowest level in the study based on instructor evaluations. The study identified that educators and system designers need to establish shared agreement that leads to higher performance. Many technology challenges in system design were noted as limitations in the study. The study further noted that the challenges with technology need to be carefully mitigated in order to ensure that the potential value to student learning is realized.

Toto et al. (2008) introduced a two-year study in which tablet PCs were issued to 64 engineering faculty at Pennsylvania State University to explore the advantages and disadvantages of using technology in the classroom. During the first year of the study, 34 tablets were issued and 30 were issued in the second year due to popularity of the study. The faculty members were assessed on teaching efficacy, computer skills efficacy, and technology acceptance. Qualitative and quantitative data were collected during the longitudinal field study. The students' perception of ease of use for the tablet PCs was higher in the first year of the study ($t=2.867$, $p=0.006$) than the second year ($t=2.008$, $p=0.050$). This difference pointed to the higher percentage of users unfamiliar with tablet PC technology in the second sample (40% vs. 24% unfamiliar). Qualitative research measured that participants in the second year of the study were also less engaged with the technology. The authors noted that there was a higher intention to use the technology among the first group of the study. The increase in intention to use was due to the admission requirements of writing a proposal on how to use the technology in the classroom for first year participants. No statistical difference was noted in teaching efficacy between the participants. The results of this study showed that prior exposure to technology and intention to incorporate technology into the classroom improves user acceptance in this case. Having role models in the university to support users of the technology also improved user efficacy. These findings led to the recommendation of using a community of practice to support users with no prior exposure or experience with technology.

Showing the varying capabilities of the devices that are appropriate for mobile learning systems, Economides and Nikolaou (2008) identified an evaluation method to decide which devices will meet the requirements for mobile learning. Although there are various names for handheld devices, Economides and Nikolaou focused on devices with the following capabilities: information and knowledge access and storage, asynchronous and synchronous communication, entertainment, and organization and management. It was shown that these capabilities afford students the opportunity to confront any situation that presents itself in an education setting. Disadvantages to handheld devices in the classroom were identified as the small form factor of the devices, less than optimal data input, battery life, and low processing capabilities. In the evaluation process, the three areas that were covered were usability, technology, and function. Usability was defined as the ease of understanding, learning, and remembering use of the device. The technology criteria focused upon performance, connectivity, security, compatibility, and reliability. Function was evaluated for quantity and quality of features and tools within the devices. The study looked at 148 devices by various manufactures available at the time of the study and rated each category graphically for comparison between units. The results showed that 90% of the devices could be used as mobile phones and more than 50% had digital cameras. Most devices offered less than 5 hours of autonomy, which is problematic for student learning situations. The authors noted that screen size between the devices was not a level basis in which to evaluate the devices since the equitability of smaller form factor led also to losses in the usability category. The results of the study led to a singular data collection for the applicability of varying handheld devices to use with student learning applications.

While many prior studies have focused upon the small form factor and clumsy user interfaces, newer studies have been focused upon making the most out of technology that is more fully featured and easy to use. Meurant (2010) focused upon the potential for iPads to revolutionize English as a second language curriculum stating that learning in this targeted area will be largely computer-mediated. The use of online resources and collaboration with other non-native speakers could dramatically improve English as a second language education. Meurant identified a set of features that are available in newer mobile devices, such as the iPad, and identified ways to integrate their use into curriculum. Stating that prior research has shown iPads have only been implemented in higher education as marketing tools, e-readers, and alternatives to PCs, Meurant proposed that more curriculum should be modified in order to take advantage of the features available in the new technology. Strengths with the iPad were identified as mobility, the ability to store reference material, the potential to integrate multi-media and text resources from publishers, simplicity, and ability for collaboration. Meurant focused on the necessity for educators, curriculum developers, and publishers to create hybrid curriculum that makes the best use of the technology that is available to students. The increasingly ubiquitous availability of wireless networks within higher education also contributed to the ability for students to be more mobile, flexible, and productive in all aspects of education. Meurant noted that the technology is available, but the strategy and design is not yet available to make these mobile systems effective as learning tools.

The research in Echeverria et al. (2011) identified challenges with implementing ICT systems into the higher education classroom stemming from the technology selected for the system. The results of Chung, Kuo, and Liu (2010) outlined technology and implementation challenges that may lead to poor usability or ultimate system failure. The research in Toto et al. (2008) demonstrated the need to properly address user acceptance and technology challenges with ICT systems in the classroom. Toto et al. also showed that there were differences in implementation success based upon users' prior exposure to the technology used in the implementation and showed that a community of users needs to be established to mitigate those challenges. Management of student engagement and student distraction from the use of technology was also a challenge within ICT system implementation (Thomas, O'Bannon, and Bolton, 2013). Meurant (2010) noted that the challenges in ICT system implementation revolve not only around the technology, but also the collaboration with designers to integrate the systems in a way to maximize the value added benefit provided by the ICT system.

Measurement of Implementation Success

Piki (2010) identified that no uniform method existed for measuring ICT system success. User acceptance of technology, in various forms, has been used to measure technology usage (Ball & Levy, 2008; Sumak, Polancic & Hericko, 2010; Birch & Irvine, 2009; Anderson, Schwager & Kerns, 2006). Though user acceptance has been used as a criterion, Wong and Li (2008) proposed using other constructs specific to the education environment may lead to a better measurement of implementation success.

In addressing uses of collaborative technology in the classroom, Piki (2010) identified that recent advances in collaborative technology had made applications for student learning more attractive in the classroom. Despite the popularity and potential value, Piki noted that there was no uniform process to implement and evaluate collaborative learning systems in the classroom. Piki addressed the post implementation evaluation of using collaborative technology in business education classrooms. Piki cited a study by Dohn (2009), which identified that collaborative technologies are not yet uniformly integrated in higher education.   Their case study explored user evaluations of a video conferencing system implementation for collaboration in business curriculum. Their sample included 43 students of varying demographics such as educational background and age. Most students in the study had prior exposure to collaborative video technology, but none had exposure to such technology applied into the classroom environment. The study noted that quantitative experimental studies are most common in group research, but qualitative field studies can provide longitudinal results but are more costly and time consuming. Piki selected a qualitative approach to evaluate the system by collecting participant video recordings and performing observations of the system in use. The system was deemed an appropriate tool for collaboration due to its flexibility and availability outside of the classroom. Student user satisfaction and engagement varied based on student perception of usefulness. A statement of purpose or goal of using the technology, rather than just implementing it as a supporting resource, also was noted to improve student perception and use. Limitations of the study include the focused nature of examining only business curriculum. A broader implementation may lead to more accurate results of generalized collaboration among students.

Ball and Levy (2008) studied the factors that influence faculty members' acceptance of technology. In their causal-modeling study they created a survey instrument to ascertain the areas that may influence a faculty member's intention to use technology, including computer self-efficacy, computer anxiety, and experience with the use of technology. The survey was built based upon surveys in other research. Computer self-efficacy was the only factor that was statistically significant ($p < .005$) in prediction of intention to use. Limitations of the study and future research recommendations noted that larger and more diverse samples could be used to add to the body of knowledge. The research in Ball and Levy was restricted to a small private college and the sample size was 56 faculty members. Ball and Levy suggested that more research should be conducted to see if intention to use is a significant predictor of actual use of emerging technology in the classroom.

Sumak et al. (2010) used the Uniform Theory of Acceptance and Use of Technology (UTAUT), a technology acceptance theory by Venkatesh et al. (2003), to identify which key indicators can be used to predict the acceptance of a new virtual learning environment. A causal-modeling study with a sample of 235 undergraduate students was created to assess which constructs of UTAUT were predictors of use for undergraduate students in engineering and computer science fields. Their study demonstrated that performance expectancy, facilitating conditions, behavioral intention and social influence were determinants of use of their new virtual learning environment ($r=0.70$, $p < 0.05$). The conclusions of the study revealed that UTAUT was a good measure of technology usage in an educational environment, particularly in the area of usefulness and behavioral intention. Sumak et al. indicated that professors, teaching assistants, and mentors should be studied in future work to gain a more holistic view of the factors that lead to the use of ICT systems by all educational users.

Birch and Irvine (2009) explored the variables in UTAUT that influenced the use of technology by teachers in the classroom. The authors noted that the school systems encouraged the use, and had the capacity to implement the systems, but did not take into account faculty acceptance of using the technologies in the classroom. Birch and Irvine used UTAUT to study predetermined factors that lead to behavioral intention to use information and communication technology in the classroom environment. Birch and

Irvine also studied age, gender, and voluntariness and their effect on the four determinants of UTAUT. This study used qualitative and quantitative approaches to determine which constructs were statistically significant in determining use. The sample used in the study included 82 students in a secondary teacher preparation program at a Canadian university. As a result of the quantitative and qualitative study, only 27% of the variance of use was explained by UTAUT. Effort expectancy was found to be the only significant predictor of pre-service teachers' intention to use information and communication technology in the learning environment. Limitations in the study noted that the predictors could change once pre-service teachers have practical experience in the classroom after graduation. Birch and Irvine identified that future research needs to be done to determine interventions that would increase effort expectancy. The authors also noted that technology skill should be measured in future studies to determine the impact of user self-efficacy on effort expectancy. Birch and Irvine also suggested future experimental research in the implementation of a specific educational technology system to remove the generalization of the term "technology" for more accurate measurement.

Anderson et al. (2006) studied UTAUT as a measurement of ICT success for business faculty in the higher education environment. Their study started by reviewing the literature in using Tablet PCs in education, and most importantly the acceptance by faculty for these devices in the classroom. The researchers expanded upon the prior research in faculty acceptance by applying UTAUT to the Tablet PC discussion. Data was collected from 37 faculty members of varying age and experience in the college of business using a web-based survey distributed through the campus email system. The questions in the survey were based on Venkatesh et al. (2003) using UTAUT, only changing the verbiage of the system type to Tablet PC. The results showed that performance expectancy was the most important identifier of use of Tablet PCs by faculty with beta of .466 ($p<0.01$). The remaining constructs of UTAUT were not statistically significant in their study. The conclusion of the study showed that a great deal of attention should focus on faculty perception that technology will be of use in the classroom in order to have a higher probability of ICT system integration into the classroom.

Wong and Li (2008) examined the role that ICT systems play in the education environment. The authors studied teaching and administration variables to determine a perception of student learning improvements with the use of the ICT system. There was a belief that ICT systems can play an important role as more than just an educational tool, but also as a driver for educational change. ICT systems had not been created as a pedagogical tool, but had been created rather as a system to improve information sharing and communication for business and industry. The research completed in Wong and Li pointed out that ICT systems had recently adapted to a new educational environment and had been used as a driver for larger educational reform. Wong and Li studied teacher variables and school variables to determine accurate predictors in perceived student learning improvements. The sample included 963 teachers and 122 schools. The results showed that 86% of the variance in perceived student learning was at the teacher level and 14% was at the school administration level. Change in pedagogy was a strong predictor ($\beta = 0.439$, $t(121) = 12.168$, $p = .01$) and implementation strategies were a weaker predictor ($\beta = 0.216$, $t(121) = 6.614$, $p = .01$) at the teacher level. At the school level, perceived changes in pedagogy was a strong indicator of perceived student improvement ($\beta = 0.480$, $t(116) = 6.231$, $p = .01$). The conclusions showed that school climate and collegiality established an environment to better perceive ICT systems and the impact on student learning. Wong and Li noted that a focus on the educational environment and collegiality among teachers and administrators is needed to effectively implement ICT systems. Future research identified in the study stated that there needs to be a focus upon collegial capacity in schools and ICT implementation strategies.

Although quantitative studies are more common, Piki (2010) identified that qualitative field studies can be a better measure of implementation success. Piki also stated that there is a lack of longitudinal studies in implementation evaluation for ICT systems. Pieces of implementation success have been researched at length in prior studies. For example, Ball and Levy (2009), Birch and Irvine (2009), Anderson et al. (2006) and Wong and Li (2008) examined many variables that lead to system success, but did not discover a common method for the measure of implementation effectiveness.

Education as a Special Case Environment

The education environment has a unique set of characteristics that separate the user population and environment from that of business and industry. Huai (2008) identified that studies in ICT implementation are much fewer in the education environment compared to business and industry. Meyer and Xu (2009) discussed the drivers within education that lead toward ICT use and how they affect intention to use the technology. Roschelle et al. (2010) showed that system use may vary in education longitudinally and that faculty users were the primary driver of system success. Sang et al. (2010), Wang, Wu and Wong (2009), and Huang et al. (2011) studied how technology acceptance models differ with educational users.

ICT systems play an important role in educational delivery methods, but the implementation of those systems used in business and industry has had less than optimal implementation strategies. The literature review in Huai (2008) showed that there have been many studies that examine user acceptance and adoption of technology in many fields, but there are minimal studies that adequately identify behavioral intention of teachers to use technology. Because of the varying results of technology acceptance studies, Huai chose to study teacher acceptance of technology in Taiwanese universities. Huai created a causal model of factors that lead to behavioral intention to use technology by faculty. The causal model studied in Huai reflected the modifications to TAM in Venkatesh and Davis (2000), using that model to study teacher intention to use technology. The sample included 258 faculty at private and public universities in Taiwan and the results of the study accounts for 66% of the variance in behavioral intention. Perceived usefulness had a positive impact on intention to use, perceived ease of use did not impact behavioral intention, but it did positively affect perceived usefulness, Computer self-efficacy also strongly impacted ease of use and was the single largest factor in behavioral intention to use technology by faculty. Subjective norm was not a significant predictor of use, which shows that colleague input did not significantly impact teacher perception.

Meyer and Xu (2009) stated that, in the minds of educational leadership, technology has become a silver bullet that could solve the problems in higher education in terms of performance and productivity. Higher education institutions have grown interested in seeing technology incorporated into the classroom, but without faculty acceptance and use of the technology the systems have no impact. Meyer and Xu used data from the 1999 and 2004 National Study of Postsecondary Faculty to create a causal model of factors that lead to faculty use of technology. The data set included 2,748 faculty from research institutions and 3,112 faculty from community colleges. The study tracked the number of faculty who used web resources in their classroom in the last two years, faculty gender, education level, and age. The path coefficients that show the strongest predictors of faculty technology use are highest degree (0.154), increased teaching load (0.151), and age (-0.099) at research institutions ($\chi^2(4, N = 2{,}748) = 11.43$, $p = .022$) and highest degree (0.101), teaching load (0.159) and age (-.044) at community colleges ($\chi^2(4, N = 3{,}112) = 11.43$, $p = .027$). Future research areas were identified as needing to find a coordinated correlation between institution types, as well as repeating the study using newer data. Research related to faculty motivators for using technology in the classroom is also suggested.

Roschelle et al. (2010) performed an experimental study adopting a collaborative learning software package developed for a school in Chile to a U.S. primary school environment. This study follows up on research by Zurita and Nussbaum (2004) that implemented computer supported collaborative learning systems into a school in Chile. In Roschelle et al., TechPALS was adopted into the elementary school math curriculum in a fourth grade classroom. The goal of the implementation was to integrate the software into the existing teacher-led presentations by allowing for collaborative scenarios for student-centered education. The results of the study showed that student learning was increased with the experimental system [$F(1,155)=4.08$, $p < .05$]. The study noted that while student learning increases were mixed in the first year of the study, the second year of the study provided consistent increases in student learning with the system implementation. Several discussion points around faculty involvement were described. Roschelle et al. showed that students were more involved and enjoyed the system more when the faculty member was active in it with the students. Their discussion also showed a necessity for training of faculty in order to maximize the potential value to the students. They noticed an increase in student satisfaction when teachers took ownership of the system during learning experiences. Future implementations of the system should include proper planning and development of curriculum and materials for instructors. In a future publication, Sharples and Roschelle (2010) continued the idea that advances in learning theory are still needed to compliment the technology capabilities.

Despite increased availability and support of ICT systems in education, relatively few teachers are interested in integrating ICT in the classroom. Sang, Valcke, van Braak, and Tondeur (2010) studied teaching behaviors that can be predictors of educational technology use. To study how teaching behaviors may impact behavioral intention, the study focused on pre-service teachers (N=727) at several higher education institutions in China. The independent variables of gender, teaching beliefs, teaching self-efficacy, computer self-efficacy, and computer attitudes were studied in order to determine behavioral intention to use ICT systems in education. Teaching self-efficacy, contrary to computer self-efficacy, was defined on the subjects' perception of their capabilities to organize and execute actions required in the classroom. The five independent variables were formed into a causal model affecting the dependent variable of ICT system integration. The results of the study showed that teacher specific variables, including teaching beliefs, self-efficacy, and computer attitudes, were able to predict ICT system use. Gender did not have an impact on ICT system integration. The study noted that future research should include a longitudinal study to track changes in thinking during teachers' increased experience on the job. Other limitations in the study include a focus only on Chinese teaching students, not on practicing teachers or on teachers from other cultures. The research in Sang et al. showed that the unique characteristics of teachers change behavioral intention to use ICT systems.

Huang et al. (2011) explored the role of management support in online technology adoption. The study examined the effect of perceived usefulness, ease of use, subjective norm and management support on faculty technology acceptance of online technology. The population of the study included 169 full-time college teachers at two colleges in Taiwan in 2009. The researchers used prior studies in technology acceptance to develop 11 survey items related to perceived usefulness, ease of use, subjective norm, and behavioral intention. Using structural equation modeling, the researchers determined that perceived usefulness, ease of use, subjective norm and management support had a positive effect on teachers' intention to use the online technology. Ease of use was the highest factor in effecting intention to use. Social influences specific to faculty use were shown to be closely associated with teachers' awareness of usefulness. The study found that management support, such as compensation and training for ICT related activities, had a critical role in intention to use online technology by faculty and that support was a crucial management strategy to improve system success. Management support positively affected perceived usefulness ($\beta = .23$, $t(164) = 2.88$, $p < .01$), ease of use ($\beta = .38$, $t(164) = 4.67$, $p < .001$) and subjective norm ($\beta = .42$, $t(164) = 4.97$, $p < .001$). The researchers proposed future research into the role of communication into faculty intention to use. Limitations on the study described that the study lacked generalizability due to the sample of only full-time college instructors in Taiwan.

Again, noting that mobile learning studies were in their infancy, Wang et al. (2009) studied individual characteristics in education settings that were determinants of mobile learning acceptance. The authors stated in their literature review that mobile commerce and e-learning had received extensive attention in the literature, the study of mobile devices in education was still new in the literature. It was also clear that very little research has been done to identify the factors that affect educational users intention to use technology. After a thorough literature review in technology acceptance, Wang et al. used UTAUT by Venkatesh et al. (2003) to study educational user intention. To incorporate the uniqueness of the environment, Wang et al. also included two new constructs to account for mobile learning specifically including perceived playfulness and self-management of learning. Perceived playfulness measures the user's spontaneity as it relates to technology usage and is a construct measured in past web based technology studies. Self-management of learning has been a construct in online learning studies and was included due to the online component with using mobile devices in the classroom. As behavioral intention was the dependent variable in this study, the authors also decided to omit facilitating conditions and user experience from the original UTAUT model. The sample for the study included 330 survey responses from K-12 and higher education students in Taiwan with an average of 8.15 years of computer experience and 5.5 years of Internet experience. The results of the study showed that 58% of the variance was accounted for. The hypothesis of performance expectancy, effort expectancy, perceived playfulness, self-management of learning, and social influence were all supported and positively impacted behavioral intention. The variance differences in the UTAUT model between male (53%) and female (68%) were studied and determined not to be significant. That being said, social influence was significant with male users, but not female users, which contradicted findings in Venkatesh et al. (2003). Age was also a differentiator with those over 30 years of age accounting for 53% of the variance, and those under 30 accounting for 62% of the variance with the UTAUT model used. The authors concluded that this research could lead to design elements that should be included in future work. First, mobile learning systems should be designed with flexibility in mind where the users can select what they would like to learn, control their learning progress, and record their own progress and performance. It was also shown that implementers should focus on showcasing the performance possibilities with the ICT system, as performance expectancy was a contributor to use. Social means of influencing use should also be designed into future system implementations. While gender and age differences did not have a significant impact on use, design considerations should surround the moderating effect of age and gender on social influence and effort expectancy.

Huai (2008) and Meyer and Xu (2009) studied survey data from higher education faculty to determine the factors that lead to faculty use of technology. Huang et al. (2011) and Sang et al. (2010) studied the drivers of ICT use and how it affected faculty intention to use the technology. The results showed that faculty have a unique set of characteristics, including teaching load and degree level, that separate that user group from that of traditional technology consumers. Wang et al. (2009) created new constructs to measure acceptance of technology by students. Roschelle et al. (2010) applied research from the seminal article in mobile collaborative systems and found that faculty training and curriculum development are essential to gain usability by faculty and instructors. The research found that management support, compensation, and training were vital elements for system implementation success.

Summary

As stated previously, the goal of this study was to create an approach for ICT system implementation into higher education. This chapter reviewed the literature that supports the problem statement presented in the first chapter. It also outlines the five major areas contributing to the problem including the sporadic nature of past implementations, mobile collaborative systems, challenges with implementing ICT systems, measurement of those systems, and the unique characteristics of the education environment.

The research shows that research into implementing ICT systems in education is still in its infancy when compared to implementations in business and industry. Mobile devices are used to promote collaboration among students and faculty in the classroom and have been shown to improve student learning. The challenges with the technology regarding capabilities as well as classroom management have also been discussed. Several characteristics in educational users also contribute to the challenge of creating an implementation model for ICT systems. This literature review provides a holistic view of the main contributors to support the research proposed in this study.

Chapter 3

Methodology

Introduction

This chapter describes the methodology that was used to address the following research questions:

1. What criteria must an implementation model for incorporating ICT learning systems in higher education meet in order to be considered successful?

2. How can an implementation model for incorporating ICT learning systems in higher education be evaluated against those criteria?

The following sections of this chapter describe the design-science research framework and why it is appropriate to address the research questions in this study. The approach section will detail the methodological steps required to complete the study. These steps include the establishment and validation of product criteria, artifact development and artifact evaluation. Finally, the resources required to complete the study and the proposed timeframe for completion will be discussed.

A design-science research study was proposed to address the research questions in this study. Design-science research is built around the fundamental questions of utility that is provided by a new technology solution (Hevner et al., 2004). Ellis and Levy (2009) stated that development research is appropriate to address a problem where there is not an adequate solution, which in this case is the lack of a generalized implementation model for mobile collaborative learning systems. To address the first research question on defining the utility that an implementation model for ICT systems provides, potential success criteria were selected using data collected from a literature review, as explained by Ellis and Levy (2010).

The success criteria were evaluated and validated through an expert panel of educators, implementers and administrators. The expert panel was facilitated using the Delphi method to collect consistent common consensus through multiple iterations of meetings. Similar to this proposed study, the Delphi method has been used by Yang and Lu (2012) to better understand user criteria in selecting a knowledge management system. The same technique was used in Chang, Gable, Smythe, and Timbrell (2000) to determine issues in enterprise resource planning system implementations.

To address the second research question on how the utility of a model for ICT system implementation can be evaluated, an evaluation panel was established to assess the efficacy of the model to satisfy the validated criteria. Development research and design science methodologies establish an evaluation method to test artifacts that are created to solve technology related problems. Ellis and Hafner (2006) and Zurita, Baloian, and Baytelman (2009) used development research to define criteria that a communication environment needed to meet to support collaborative learning and how those criteria can be used to evaluate the success of that system. This process for development research follows the research methodology fully described in Hevner et al. (2004). Hevner et al. established guidelines to design and evaluate an artifact that solves information systems problems using technology-based solutions. The study used design-science research methods in a similar fashion to identify and validate potential success criteria in which to develop the model.

Approach

The approach outlined below covers the required steps to complete the study. The major steps involved in design science research were followed as defined in Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) and Ellis and Levy (2010). These steps include identifying a problem, defining criteria, design and development of the artifact, evaluation of the artifact and communication of results. A critical step in the development process is the pre-evaluation of the defined criteria (Ellis & Levy, 2010; Offermann, Levina, Schonherr & Bub, 2009). Problem identification was discussed in detail in Chapter One and supported through the literature review in Chapter Two. The following sections describe each subsequent step within the design science research approach used in this study.

Definition and Evaluation of Criteria

As described in previous chapters, prior studies in ICT implementation in higher education have identified success factors and future research areas that are necessary in order to develop a widely applicable implementation model (Caballe, Xhafa & Barolli, 2010; Piki, 2010; Roschelle, Rosas & Nussbaum, 2005). The development of implementation criteria was derived from the historical analysis of prior studies in implementing ICT systems in the education environment. Table 1 lists the databases that were used in the selection of the studies. Articles were located using a preliminary search with keywords pertaining to ICT system implementation, educational technology, technology integration in education, collaborative learning and technology challenges. A secondary search process included a backward and forward search from each article located in the first search. Items that were either shown to be statistically significant in ICT system implementation or those listed as potential areas for future study were selected for the preliminary list. These items were complied by the researcher into a preliminary list of potential criteria for expert panel validation (see Appendix A). This preliminary list contains each success factor and the reference to the study in which it was derived.

Table 1: Databases

ABI/Inform Complete-ProQuest
ACM Digital Library
IEEE Computer Society Digital Library
ScienceDirect – Elsevier
Dissertations and Theses – ProQuest

The Delphi method was used to review and validate the potential criteria derived from the literature review. The Delphi method was used as an iterative approach to generate, evaluate and gain consensus among an expert panel. The selection of expert panel participants is discussed in the next section. The Delphi approach has been used in prior information systems studies to identify, prioritize and evaluate key issues, strengths and weaknesses in information systems (Chang et al., 2000, McKay & Ellis, 2013). This process for preliminary success criteria was used in Yang and Lu (2012) to develop a list of confirmed evaluation criteria for design research.

To start the criteria validation process, the panel was given a brief description of the research, a description of the Delphi process and the full list of potential criteria identified in Appendix A. Following the process used in McKay and Ellis (2013) and Biello (2006), the group was given the instructions as listed in Appendix B. Using an electronic form, the panel was asked to rate each criterion using a 5-point Likert Scale ranging from Strongly Agree to Strongly Disagree. Panel participants were asked for feedback regarding any rating less than 3.0. Expert panel participants were given the opportunity to suggest wording changes or ask for clarification in the description of each criterion. The expert panel were also given the opportunity to suggest additional criteria to be included in the next round.

As outlined in Biello (2006) and Chang et al. (2000), the results of the first round is intended to create a list, or inventory of criteria, to be confirmed in later rounds. Yang and Lu (2012) used a similar first round approach to alter and confirm an initial set of criteria for further validation. The results from the first round of expert panel input were collected and documented by the researcher by separating the criteria into several categories. Any criteria that unanimously received a rating of less than 3.0 were removed from further consideration. The remaining list of criteria was separated into two sections for the second round of expert panel interaction. The first section of the list consisted of all criteria that were affirmed by all panel participants. The second section of the list consisted of all criteria by at least one member of the expert panel, but did not achieve consensus. The researcher took the suggestions for wording into account and made any necessary changes for clarification in future rounds. Both of these sections included the mean and standard deviation for each criterion rating from the first round of panel participation

The second round of expert panel involvement sought confirmation of the implementation criteria. To begin the second round, the panel was given the affirmed criteria from the first round as shown in Appendix C. The remaining criteria list developed by the researcher with the panel results from the first round were given to the panel as shown in Appendix D. For the remaining criteria, the panel was asked to review participant feedback for less than favorable ratings. The researcher also included any responses to questions or requests for clarification in a similar format. After reviewing participant feedback and researcher clarification, the participants were then asked to again rate the impact of the criterion on model development using a 5-point Likert Scale ranging from Strongly Agree to Strongly Disagree. As in the first round, panel participants were asked for feedback regarding any rating less than 3.0. For the category of criteria that had suggested wording changes, the panel was asked to review the wording changes adopted by the researcher and be asked to rate the criteria based upon the new wording. The participants also rated criteria suggested by panel members in the first round. After the second round, criteria that reached consensus above 3.0 were considered validated for the development phase of the study. Any criteria that unanimously scored below a 3.0 were not used in the development of the model. Criteria that did not receive consensus above or below the 3.0 threshold were documented with each panel participant’s feedback and a brief response by the researcher for a third round of panel input.

For the third and subsequent rounds, participants were presented with a list of criteria that did not achieve consensus along with the feedback received during the previous round of questioning. Participants were then asked to rate the impact of the remaining criterion again using the same scale after reviewing the feedback from the second round. As with the second round, expert panel participants were asked for feedback for any rating of less than 3.0. The researcher compiled the results from the for the third and any subsequent round of questioning. Any criteria with consensus above

3.0 were included in the development of the implementation model. Any criteria with consensus below 3.0 were excluded from future consideration. The remaining criteria without consensus were compiled by the researcher to include the comments by expert panel participants accompanied by a brief response from the researcher. The process described for the third round of the Delphi process continued iteratively until every criterion had achieved consensus. For the criterion that did not achieve consensus for consecutive rounds with no change in feedback, the expert panel was asked how they would like to move forward with the criteria development process. This Delphi approach followed research described in Yousuf (2007), which also states that the Delphi approach is perceived as useful for educational settings. Figure1 shows a flowchart for the Delphi process.

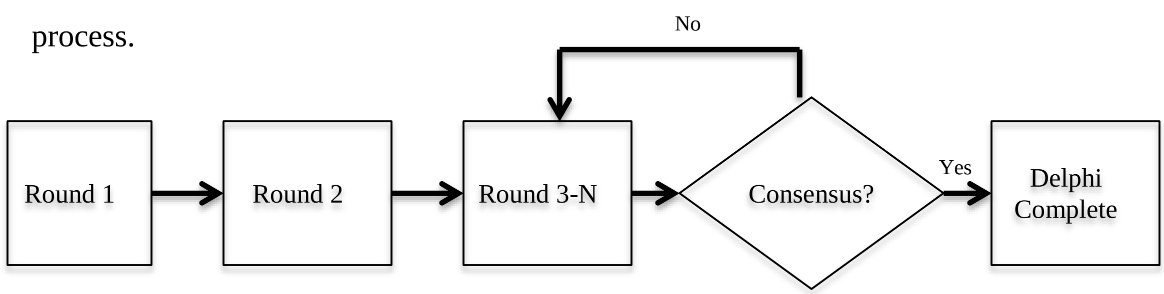

Figure 1. Delphi Process

This approach to criteria development followed the guidelines of design science research as defined in Hevner et al. (2004). The identification and pre-evaluation or validation of the criteria also followed the design science research approach in Offermann et al. (2009) and Ellis and Levy (2009). The results of this method led to a validated set of product criteria that was necessary for the development of the implementation model.

Expert Panel

In order to ensure that the expert panel was representative of those impacted by the study, the panel included full time faculty, technology implementer and higher education administrator roles. Participants in design science research studies should include those impacted by its use, which include instructors, designers, and supervisors (Richey & Klein, 2007). Faculty members were included, as proper integration into pedagogy, rather than pure availability of technology, is imperative to student learning improvements with ICT systems (Souleles et al., 2014; Wagner et al., 2005). Higher education administrators were also included in the expert panel, as administrative support has been shown to improve faculty acceptance of technology (Caballe, Xhafa, and Barolli, 2010; Lim, 2006). Each member of the expert panel had at least five years of experience in higher education. The participants in the study were selected from various educational disciplines in order to identify criteria that can be used across broad educational applications. In contrast, most prior studies have been conducted in specialized settings (Caballe, Xhafa & Barolli, 2010; Piki, 2010; Sumak, Polancic, and Hericko, 2010). Table 3 lists the expert panel participants selected for this study.

As identified in Skulmoski, Hartman and Krahn (2007), the sample size for Delphi research in information systems studies has varied between nine and well over one hundred participants. Similarly to the study in McKay and Ellis (2013), a target sample of at least ten participants was used.

Table 2: Expert Panel Participants

#	Researcher Category	Title	Education	Academic Discipline	Experience
1	Technology Imp.	Educational Technologist	Masters	N/A	10+
2	Technology Imp.	Internet Systems Admin	Masters	N/A	5-10
3	Administrator	Chief Academic Officer	Ph.D.	Culinary	10+
4	Administrator	Dean	Masters	Business and Technology	10+
5	Administrator	Chief Academic Officer	Ph.D.	Business	10+
6	Administrator	Dean	Masters	Health Science	10+
7	Administrator	Dean	Ph.D.	Business and Human Service	10+
8	Administrator	President	Masters	N/A	10+
9	Administrator	Director	Masters	Computing and Technology	10+
10	Full Time Faculty	Professor	Masters	Health Science	10+
11	Full Time Faculty	Assistant Professor	J.D.	General Education	10+
12	Full Time Faculty	Instructor	Bachelor	Automotive Service	5-10

Participants for the expert panel were recruited through an already existing educational technology email distribution list at a Midwest private higher education institution. The expert panel participated exclusively using email and other electronic methods for each round of questioning. The distribution list consisted of information technologists, faculty and administrators within the institution. The distribution list was sent the invitation letter listed in Appendix E. Respondents from the distribution list who met the above requirements and were willing and able to participate were selected for the expert panel. A minimum of two participants for each role was be necessary.

Development of Artifact

Following the development and validation of the product criteria, an implementation model for ICT systems in higher education was developed. As the complexity and sheer size of the problem may render a single solution difficult or even infeasible, the ultimate problem of creating the implementation model was broken into smaller issues that address each product criterion. The affirmed criteria were separated into categories aligned with the literature review in Chapter 2. The researcher performed a literature review in order to develop an implementation model to satisfy the criteria developed and validated by the expert panel. Strategies to reach the desired state for each criteria group were developed using prior research and best practices identified in the body of knowledge. The result of this review was an implementation model to satisfy each individual criterion developed and validated by the expert panel.

The collection of implementation strategies for each criterion was then aggregated by the researcher into a model for ICT system implementation in higher education. The model included considerations and rationale that maximizes the ability for each product criteria to reach the desired state. Also included in the model was the identification of measurement methods for each success criteria based on prior research for each respective criterion. The collection and documentation of the implementation characteristics for each criterion resulted in a detailed implementation model for ICT systems in higher education.

After the proposed implementation model was drafted, the expert panel reconvened to review the proposed model for accuracy and ability to satisfy the identified criteria. Similar to research in Jones and Richey (2000) and Peffers et al. (2007), an iterative approach was used for formative evaluation of the model during development. Using the Delphi method, the expert panel was given the proposed implementation model to evaluate the ability of the proposed model to satisfy the validated criteria. The researcher noted any suggestions for modification and improvement for each criterion that did not gain panel consensus. Feedback and suggestions for improvement from the expert panel was reviewed and modifications to the implementation model were completed as necessary for each subsequent round until consensus was achieved for each criterion using the same process in the prior Delphi process. The process of pre-evaluation of the implementation model is consistent with the recommendations for an iterative design process in Hevner at al. (2004), Offermann et al. (2009), and Peffers et al. (2007). Once this iterative process was complete, a formal evaluation of the proposed model was conducted.

Evaluation of Artifact

According to Peffers et al. (2007), evaluation of an artifact varies in information systems studies from a simple demonstration of the artifact to formal evaluation of the artifact. A three-member panel determined the efficacy of the model upon completion of the proposed implementation model. The validated design criteria was addressed rather than evaluating a demonstrated implementation of an ICT system. Following the same rational for selection in the expert panel for criteria selection the evaluation panel consisted of one faculty, technology implementer and administrator in the higher education environment. The evaluation panel included participants who have a fundamental understanding of the drivers behind the use of ICT technology and its potential to add value in higher education classrooms. Each member of the evaluation panel had at least ten years of experience within higher education. The evaluation panel participants did not consist of any members involved in previous rounds. This evaluation method has been used in a very similar fashion by Biello (2006) in order to evaluate the efficacy of an artifact for validated expert panel criterion. The list of panel participants is in Table 3 below.

Table 3: Panel Participants

#	Researcher Category	Title	Education	Academic Discipline	Experience
1	Technology Imp.	CIO	Masters	N/A	10+
2	Administrator	President	Ph.D.	N/A	10+
3	Full Time Faculty	Instructor	Ph.D.	English	10+

According to Offermann et al. (2009), an expert panel can be used to evaluate the perceived viability of the artifact. The goal of the evaluation panel was to evaluate and make recommendations for further improvement of the model. This process has also been used in Biello (2006) to determine the ability of a developed model to address validated criteria sets. The evaluation panel was presented with the proposed implementation model and validated criteria. The panel was tasked with evaluating the ability of the model to satisfy the validated criterion. The model was evaluated by rating the implementation model's ability to satisfy each criterion. The panel used a Likert scale ranging from Strongly Agree to Strongly Disagree for each criterion. Qualitative feedback was also collected during the rating process for each criterion to better understand the quantitative rating. The qualitative feedback was received through the use of a comment section following the rating for each criterion. The instrument used to collect the evaluation panel rating and feedback is included in Appendix F. The results of the expert panel evaluation were compiled and documented by the researcher on the ability of the implementation model to satisfy the design criteria.

Resources

The following list of resources were necessary to complete the proposed study:

1. Access to appropriate content experts for criteria development.
    a. Faculty
    b. Technology implementers
    c. Administrators
2. Access to appropriate content experts for Evaluation Panel.
    a. Faculty
    b. Technology implementer
    c. Administrator
3. Permission to conduct the study.
    a. Approval by Nova Southeastern University IRB included in Appendix G.
    b. Approval by panel members' institutional IRB included in Appendix H.
4. Computer and Software Resources
    a. Software for writing results and analysis of data
    b. Email for communication
    c. Electronic forms for expert panel interaction

Summary

The methodology described in this chapter was deeply rooted in design science research. The design methodology was selected based upon the appropriateness to address the following research questions:

1. What criteria must an implementation model for incorporating ICT systems in higher education meet in order to be considered successful?

2. How can an implementation model for incorporating ICT systems in higher education be evaluated against those criteria?

An iterative process for the identification, validation and final selection of product criteria by an expert panel was presented. The set of criteria was used to develop a comprehensive set of design characteristics and a proposed model for implementing ICT systems in higher education.

The implementation model was evaluated using an evaluation panel on its ability to satisfy each product criterion derived from the original expert panel. The results of that data were then presented and conclusions and future research were discussed.

Chapter 4

Results

Introduction

This chapter presents the results of the research study and will be separated into four sections. The first section describes the results of the expert panel for criteria development. The second section describes the implementation model that was created as a result of the criteria. The third section outlines the evaluation of the implementation model. The fourth section presents a summary of the results of the entire study.

Criteria Development

A twelve member expert panel that consisted of technology implementers, administrators and faculty within a higher education institution was established to validate implementation criteria for ICT systems in higher education. As outlined in Chapter 3, the participants were given the initial set of implementation criteria outlined in Appendix A. The expert panel used a five point Likert scale ranging from Strongly Agree to Strongly Disagree to rate each criteria. Criteria reaching consensus above 3.0 were affirmed for the study. The expert panel was also able to provide suggestions for re-wording criteria or suggesting new criteria. After four rounds of questioning, the expert panel reached consensus on the implementation criteria.

Expert Panel Round One

The initial set of criteria used to start the expert panel process is listed in Appendix A. In the first round of expert panel participation, consensus was reached on the criteria listed in Table 4 and were affirmed for the study.

Table 4: First Round Affirmed Criteria

Criterion	Mean	SD
ICT systems implemented must include technology that is both available and accessible for classroom use by students and faculty (Caballe et al., 2010; Thomas, O'Bannon, & Bolton, 2013).	4.67	0.65
Faculty training for ICT system use must be available (Thomas, O'Bannon & Bolton, 2013; Toto et al., 2008; Roschelle et al., 2010).	4.92	0.29
Management or Administration of the institution must show support for ICT system use (Huda & Hussin, 2013; Huang et al., 2011).	4.75	0.45
The ICT system must be deliberately integrated into the pedagogy for the classroom (Caballe et al., 2010; Souleles et al., 2014; Murphy, 2011; Zurita et al., 2008; Alvarez et al., 2011; Chung, Kuo and Liu, 2010; Meurant, 2010; Wong & Li, 2008).	4.58	0.67
Faculty should have general technology self-efficacy (Ball & Levy, 2009; Huai, 2008; Roschelle et al., 2010).	4.25	0.62
Appropriate measurement of ICT system success must be in place prior to the system being implemented. (Piki, 2010)	4.33	0.78
Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009)	4.33	0.65

The expert panel suggested that the criteria regarding effort expectancy be separated to identify faculty and student users. The suggested wording from the expert panel were adopted as as follows:

1. Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009).
2. Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009).

No additional criteria or wording changes were identified in the first round of expert panel participation. No additional criteria were suggested by the expert panel during the Delphi process.

Expert Panel Round Two

In the second round of expert panel participation, the expert panel was given the remaining criteria that were affirmed by at least one participant but had not achieved consensus in round one, along with the wording changes suggested in round one as follows:

1. Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010).

2. Teaching self-efficacy, or faculty perception of the capability to organize and execute actions in the classroom, must be high (Sang et al., 2010).

3. Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010).

4. Faculty should perceive usefulness or performance expectancy of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011).

5. Students should perceive usefulness or performance expectancy of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009).

6. Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008).

7. Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).

8. Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012).

9. Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010).

10. Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013)

11. Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009).

12. Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009).

13. Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)

Feedback from each panel participant from the first round was also shared with the entire group. The remaining criteria, instructions and feedback given to expert panel participants in the second round are listed in Appendix D. After reviewing the participant and research feedback, the expert panel was asked to rate the remaining criteria. Table 5 identifies the criteria affirmed in the second round.

Table 5: Second Round Affirmed Criteria

Criterion	Mean	SD
Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010)	4.55	0.82
Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010)	3.82	0.6

During the second round of participation, the expert panel suggested wording changes to three criteria. For the criterion "Teaching self-efficacy, or faculty perception of the capability to organize and execute actions in the classroom, must be high", the expert panel felt that the word "organize" was confusing and not easily determined and was removed from the criterion. For criteria "Faculty should perceive usefulness or performance expectancy of the ICT system" and "Students should perceive usefulness or performance expectancy of the ICT system", the expert panel felt that perceived usefulness was more easily understood than performance expectancy. The criteria were reworded as follows:

1. Faculty should perceive usefulness of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011). (M=4.18, SD=0.75)

2. Students should perceive usefulness of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009). (M=4.18, SD=0.75)

Expert Panel Round Three

In the third round of expert panel participation, the expert panel was given the remaining criteria that had not achieved consensus after the second round, along with the wording changes suggested from round two as follows:

1. Teaching self-efficacy, or faculty perception of the capability to execute actions in the classroom, must be high (Sang et al., 2010).

2. Faculty should perceive usefulness of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011).

3. Students should perceive usefulness of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009).

4. Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008).

5. Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).

6. Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012).

7. Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010).

8. Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013)

9. Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009).

10. Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009).

11. Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)

The feedback from each panel participant and the researcher from all rounds were also shared with the entire group. The information given to panel participants to start round three is listed in Appendix I. As a result of the third round of panel responses, the panel affirmed the criteria in Table 6.

Table 6: Third Round Affirmed Criteria

Criterion	Mean	SD
Teaching self-efficacy, or faculty perception of the capability to execute actions in the classroom, must be high (Sang et al., 2010)	4.18	0.75
Faculty should perceive usefulness of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011)	4.18	0.75
Students should perceive usefulness of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009)	4.18	0.75
Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012)	4	0.45
Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)	3.64	0.81
Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)	3.82	0.87

The criterion with the biggest variance among the panel in this round was criterion “Older users will be more resistant than younger users to use the ICT system”. Most panel participants felt that age was becoming less of a factor, but still remained as an implementation criterion. One panel participant felt strongly that age was no longer a factor in technology acceptance with the pervasiveness of technology in higher education. The majority of the panel identified that older users are more resistant to use technology that younger users.

Expert Panel Round Four

In the fourth round of expert panel participation, the expert panel was given the remaining criteria as follows:

1. Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008).

2. Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).

3. Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010).

4. Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013)

5. Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)

The remaining criteria and feedback used to begin the fourth round is included in Appendix J. In the fourth round, the criteria "Students should perceive that the ICT system is easy to use" was affirmed for the study (M=3.91, SD=0.83).

As only one panel participant rated the remaining criteria below 3.0 in the third round, the panel was also asked how they would like to handle the criteria that did not reach consensus after this round. The panel decided to use a simple majority rating to affirm or revoke the remaining criteria for the study. Using this process, the criteria in Table 7 were affirmed for the study using a simple majority.

Table 7: Fourth Round Affirmed Criteria

Criterion	Mean	SD
Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).	3.82	0.87
Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010)	3.27	0.79
Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013)	3.64	0.67
Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)	3.64	1.03

Only one participant in rounds three and four rated all criteria listed in Table 7 less than 3.0. The participant only stated "personal experience" in the rationale for the rating. Upon the completion of round four, the expert panel process for establishing model criteria was completed. The final criteria set is listed in Appendix K.

Implementation Model Development

After completion of the expert panel process, the researcher developed an implementation model to directly address each of the criteria affirmed by the expert panel. The implementation model identified approaches for implementation and suggested measurements for those approaches. The approaches for implementation were based upon prior research in ICT system implementation in higher education. The completed implementation model is included in Appendix L.

Development of Model

The model was structured as a collection of solutions for grouped criteria categories. As a single solution for the complex problem could prove to be difficult, the criteria were grouped into smaller categories of similar research based upon the literature review in Chapter 2. The categories included technology selection, administration support, faculty technology acceptance, student technology acceptance and pedagogy integration. The grouping of criteria into categories is listed in Model Appendix A. The collection of approaches for implementation and measurement elements for each criteria category was aggregated into a holistic implementation model for ICT system implementation in higher education. To address each criteria category, the model introduced each category of criteria, provided approaches for implementation in that category, and outlined measurement for that category. The approaches for implementation in each category and the measurement strategies were derived from the review of the literature that established the criteria.

Pre-evaluation of Model

The implementation model was pre-evaluated by the initial expert panel used to affirm the criteria used in this study. The expert panel was given the criteria grouping and the implementation model developed by the researcher. Using the Delphi approach for expert panel consensus, the panel used a 5-point Likert scale to evaluate the ability of the implementation model to satisfy the given criteria. The implementation approaches and measurement identified in the implementation model were reworked based upon panel rating of criteria that did not achieve consensus above a 3.0 rating for each round of questioning.

In the first round of expert panel pre-evaluation, the implementation model satisfied all criteria except for user age. The expert panel suggested that the implementation model did not adequately address the impact of user age on system implementation. All expert panel feedback was collected and used to make improvements to the faculty technology acceptance and student technology acceptance section of the implementation model. The approach section of the implementation model for faculty technology acceptance and student technology acceptance was modified to include additional suggestions to moderate the impact of user age on implementation success. The concepts of peer collaboration and social influence were added to the implementation model for these sections prior to the second round of panel pre-evaluation.

To start the second round of pre-evaluation, the panel was given the feedback from the first round as identified in Appendix M and the modified implementation model. In the second round, only one participant rated the implementation model at less than 3.0 for any criterion. The feedback from this panel member related to the inclusion of age as a criterion, not to the effectiveness of the model to account for user age. After reiteration that the rating in this round was on the ability of the implementation to satisfy the criteria, not rating the importance of criteria inclusion, this rating was excluded and the pre-evaluation of the implementation model was completed. Table 8 below shows the expert panel rating of the effectiveness of the implementation model to satisfy each criterion.

Table 8: Pre-evaluation panel results

Evaluation of Implementation Model to Meet Criteria	M	SD
Technology Selection		
ICT systems implemented must include technology that is both available and accessible for classroom use by students and faculty (Caballe et al., 2010; Thomas, O'Bannon, & Bolton, 2013).	4.75	0.45
Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010)	4.58	0.51
Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010)	3.75	0.75
Administration Support		
Faculty training for ICT system use must be available (Thomas, O'Bannon & Bolton, 2013; Toto et al., 2008; Roschelle et al., 2010).	4.83	0.39
Management or Administration of the institution must show support for ICT system use (Huda & Hussin, 2013; Huang et al., 2011).	4.83	0.39
Appropriate measurement of ICT system success must be in place prior to the system being implemented. (Piki, 2010)	4.33	0.78
Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010)	4.08	0.67
Faculty Technology Acceptance		
Faculty should perceive usefulness of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011)	4.42	0.67
Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).	4.00	0.85
Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)	4.08	0.67
Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009)	3.83	0.72
Faculty should have general technology self-efficacy (Ball & Levy, 2009; Huai, 2008; Roschelle et al., 2010).	4.17	0.39
Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)	3.50	0.53
Student Technology Acceptance		
Students should perceive usefulness of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009)	4.42	0.51
Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008)	4.00	0.43
Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)	4.17	0.39
Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009)	4.17	0.72
Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012)	4.08	0.51
Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)	3.50	0.53
Pedagogy Integration		
The ICT system must be deliberately integrated into the pedagogy for the classroom (Caballe et al., 2010; Souleles et al., 2014; Murphy, 2011; Zurita et al., 2008; Alvarez et al., 2011; Chung, Kuo and Liu, 2010; Meurant, 2010; Wong & Li, 2008).	4.25	0.62
Teaching self-efficacy, or faculty perception of the capability execute actions in the classroom, must be high (Sang et al., 2010)	4.08	0.51
Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013)	4.08	0.51

Model Final Evaluation

A three-member panel consisting of one administrator, faculty member and technology implementer was established to give a final evaluation of the implementation model. The panel participants had no prior interaction with the research or criteria development. The panel was given the implementation criteria and model that had been pre-evaluated by the initial expert panel. The panel was asked to rate the implementation model's effectiveness to satisfy each criterion using a 5-point Likert scale. Table 9 shows the results of the final evaluation panel.

As the final evaluation panel did not have prior experience with the creation of the criteria list, the participants also provided feedback on criteria selection. The criterion of user age was identified to be of diminishing impact on technology acceptance. The final evaluation also mentioned that the implementation model should identify that training on system use and technology use could be either facilitated or self paced. The panel also reiterated the importance of establishing clear goals and objectives prior to any ICT system implementation. The group also mentioned that the implementation model should go more into detail on how to properly achieve student peer collaboration. One participant felt that the implementation model only minimally addressed the importance of establishing collaboration through the ICT system.

Table 9: Final model evaluation

Evaluation of Implementation Model to Meet Criteria	M
Technology Selection	
ICT systems implemented must include technology that is both available and accessible for classroom use by students and faculty (Caballe et al., 2010; Thomas, O'Bannon, & Bolton, 2013).	4.67
Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010)	5.00
Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010)	4.00
Administration Support	
Faculty training for ICT system use must be available (Thomas, O'Bannon & Bolton, 2013; Toto et al., 2008; Roschelle et al., 2010).	4.67
Management or Administration of the institution must show support for ICT system use (Huda & Hussin, 2013; Huang et al., 2011).	5.00
Appropriate measurement of ICT system success must be in place prior to the system being implemented. (Piki, 2010)	5.00
Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010)	4.67
Faculty Technology Acceptance	
Faculty should perceive usefulness of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011)	4.67
Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).	4.67
Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)	4.00
Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009)	4.00
Faculty should have general technology self-efficacy (Ball & Levy, 2009; Huai, 2008; Roschelle et al., 2010).	5.00
Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)	4.33
Student Technology Acceptance	
Students should perceive usefulness of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009)	4.67
Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008)	4.67
Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)	4.00
Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009)	3.67
Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012)	5.00
Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)	4.33
Pedagogy Integration	
The ICT system must be deliberately integrated into the pedagogy for the classroom (Caballe et al., 2010; Souleles et al., 2014; Murphy, 2011; Zurita et al., 2008; Alvarez et al., 2011; Chung, Kuo and Liu, 2010; Meurant, 2010; Wong & Li, 2008).	4.33
Teaching self-efficacy, or faculty perception of the capability execute actions in the classroom, must be high (Sang et al., 2010)	5.00
Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013)	4.33

Summary

The implementation model was developed to address ICT implementation in higher education. The study identified several criteria for ICT system implementation that the model should be designed to satisfy. The results of the study suggest that the model adequately addressed criteria for implementing ICT systems in higher education. The pre-evaluation and final evaluation panels were satisfied with the ability of the implementation model to address each criterion. While the initial expert panel differed in opinion over the impact of user age on system usage, the final evaluation panel was satisfied with the ability of the model to address that criterion. The final evaluation panel found that the implementation model satisfied all of the implementation criteria. User age and establishing student peer collaboration were noted as areas for future improvement to the model.

Chapter 5

Conclusions

The research performed in this study was conducted to address the following research questions:

1. What criteria must an implementation model for incorporating ICT learning systems in higher education meet in order to be considered successful?
2. How can an implementation model for incorporating ICT learning systems in higher education be evaluated against those criteria?

The first research question was addressed by convening an expert panel to develop the implementation criteria. The expert panel affirmed 19 criteria that should be addressed by the implementation model. The second research question was addressed by the development of an implementation model to address the criteria. A separate expert panel was convened to address this question and rate the ability of the implementation model to satisfy the criteria.

The scope of this study was to identify design criteria and develop an implementation model to satisfy that criteria using developmental research methodology. This study did not address specific technology, pedagogy, or student learning. The application of this implementation model is also not addressed. This implementation model can help higher education administrators, faculty and technology implementers use ICT systems in widespread higher education settings.

Implications

Practical Implications

Two contributions to practice emerged from this study. First, the study developed a set of criteria that higher education institutions can use to identify characteristics for implementation of ICT systems. This set of criteria can help these institutions identify implementation considerations for both existing and new ICT system implementations. This set of criteria was developed to be applied in widespread higher educational settings and can be applied to a number of ICT system implementations.

The second contribution to practice is the implementation model, including approaches for implementation and measurement of implementation success. The implementation model identifies measurement of each criteria group and approaches for implementation in that category of criteria. In practice, this model could be used for new ICT system implementations as well as assessing the efficacy of existing ICT system implementations using the measurement strategies.

Contributions to the Body of Knowledge

The implementation model addresses the lack of understanding of how to implement ICT systems across widespread higher education environments. Design science research was used to create an implementation to address that lack of understanding. The implementation model also addresses the differing characteristics between implementing ICT systems in higher education settings and business and industry. The study addresses the lack of a generalized implementation framework and the inability to replicate the ICT implementation model in widespread settings.

The study also contributes to the body of knowledge by the affirmation of implementation criteria through the use of an expert panel. The panel reviewed implementation criteria derived through a literature review of prior ICT system implementation research. The identification and affirmation of these criteria can serve as a foundation for future ICT system implementation research.

Future Research

Limitations of the Study

Limitations of the study surround the participation of the expert panels in the study. While the participants of the study were from widespread educational disciplines, the participants were all from the same institution. The expert panel participants were all from a private, not for profit higher education institution. Institutions with different goals, populations, and technology implementation history may rate the criteria differently. The participants were also voluntary in the study. Volunteering as a participant in the study does not necessarily ensure adequate representation of the whole. As such, the participants in the study may not be truly representative of the larger higher education population.

Another limitation of the study is the research methodology used. The research methodology uses the Delphi method to develop the implementation criteria and pre-evaluate the implementation model. The post-evaluation of the model is also done by expert panel participation. The model itself is not tested in practice in this study, nor did an external higher education institution evaluate it.

Identification of Future Research

As stated in the limitations section, this study does not validate the implementation criteria or model at another higher education institution. Future research should be conducted to affirm the implementation criteria and ability for the implementation model to satisfy that criteria by expert panels consisting of members of other institutions.

Future research could also be conducted to apply the implementation model in practice. The practical application of the implementation model could further suggest improvement to the approaches for implementation and measurement of each criterion. The implementation model could be applied to a practical implementation of an ICT system in a higher education setting. The model should be tested in varying higher education institution settings, including private, public, four-year and two-year institutions.

Summary

There is an enthusiasm to use ICT systems to support student learning in the higher education environment. There is also a history of sub-optimal adaptation of ICT systems used in business and industry when applied to higher education institutions. The higher education environment consists of faculty and student user populations, which differ from that of business and industry. In addition, there is a lack of understanding on how to effectively implement and evaluate these systems in higher education. To address the lack of a model that appropriately addresses ICT system implementation in higher education, this research study was conducted. The goal of the study was to address the criteria that an implementation model should meet to be considered successful, and to create a model for implementation based upon those criteria.

To address the goals of the study, a design science research approach was used. First, an expert panel consisting of faculty, administrators and technology implementers was convened to establish the implementation criteria. Starting with a preliminary list of criteria derived from a literature review, a Delphi approach was used to attain consensus on the criteria. The expert panel rated each initial criterion using a 5-point Likert scale. The panel also was able to suggest new criteria or wording changes to the preliminary criteria. After four rounds of the Delphi process, a final list of 19 criteria was developed.

Following the development of the criteria list, an implementation model was developed to address that criteria. The implementation model identified categories within the criteria and implementation approaches for each category. The approaches for implementation also identified strategies for measuring each criterion. The implementation model was then distributed back to the expert panel for pre-evaluation. The expert panel evaluated the ability of the implementation model to satisfy implementation criteria. After suggestions for modification were integrated into the model, a second round of expert panel rating was conducted. After the second round, the expert panel was satisfied with the ability for the model to satisfy the implementation criteria.

Once the pre-evaluation of the implementation model was completed, a new expert panel consisting of one administrator, faculty member and technology implementer with no prior exposure to the research was convened. This second expert panel was provided with the implementation model and the criteria developed by the initial panel. Using the same 5-point likert scale, the panel gave a final rating for the ability of the implementation model to satisfy the given criteria. The final evaluation panel found that the model appropriately addressed the criteria developed by the initial expert panel. The panel also suggested future improvements to the model.

Upon completion of the implementation model, limitations of the study and suggestions for future research were identified. The contributions to practice and contributions to the body of knowledge were also identified.

Appendix A

Preliminary Criteria List

The following potential criteria have been identified as potential criteria used to develop an implementation model for ICT systems in higher education. Each criterion has been derived through a thorough literature review of ICT system implementation in higher education. The relevance of each criterion will be reviewed by an expert panel for its inclusion in the development process.

3. ICT systems implemented must include technology that is both available and accessible for classroom use by students and faculty (Caballe et al., 2010; Thomas, O'Bannon, & Bolton, 2013).

4. Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010).

5. Faculty training for ICT system use must be available (Thomas, O'Bannon & Bolton, 2013; Toto et al., 2008; Roschelle et al., 2010).

6. Management or Administration of the institution must show support for ICT system use (Huda & Hussin, 2013; Huang et al., 2011).

7. The ICT system must be deliberately integrated into the pedagogy for the classroom (Caballe et al., 2010; Souleles et al., 2014; Murphy, 2011; Zurita et al., 2008; Alvarez et al., 2011; Chung, Kuo and Liu, 2010; Meurant, 2010; Wong & Li, 2008).

8. Teaching self-efficacy, or faculty perception of the capability to organize and execute actions in the classroom, must be high (Sang et al., 2010).

9. Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010).

10. Faculty should perceive usefulness or performance expectancy of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011).

11. Students should perceive usefulness or performance expectancy of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009).

12. Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008).

13. Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).

14. Faculty should have general technology self-efficacy (Ball & Levy, 2009; Huai, 2008; Roschelle et al., 2010).

15. Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012).

16. Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010).

17. Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013)

18. Appropriate measurement of ICT system success must be in place prior to the system being implemented. (Piki, 2010)

19. Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009).

20. Lower effort expectancy will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009).

21. Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)

Appendix B

Delphi First Round Instructions

Dear Expert Panel Participants,

Thank you for your interest in participating in this research study. To reiterate what was said in the invitation email, the goal of this expert panel is to review and validate a list of potential criteria for implementing Information and Communication Technology (ICT) in higher education.

Using the online form at the link below, you will find an initial list of criteria developed by the researcher and the references where each criterion was derived. Please rate the impact each criteria on implementing ICT in higher education on a 5-point Likert scale according to the table below:

Scale for Criteria Rating
5. Strongly Agree
4. Moderately Agree
3. Neutral
2. Moderately Disagree
1. Strongly Disagree

You will be asked for a short rationale for any criterion that you rate at less than 3. Criterion rated less than 3 will be considered insignificant for the development of the implementation model. For this round of expert panel discussion, you may also suggest any potential wording changes for each criterion. You may also suggest criteria that may not already be included in this list. Please indicate any suggested wording changes or additions also using the online form at the link below.

<<link to Google e-form>>

Thank you again for your willingness to participate in this study.

Sincerely,

Thomas E Kurtz
Researcher

Appendix C

Delphi Second Round Invitation

Dear Expert Panel Participants,

Thank you for your first round responses. Of the 19 criteria that were rated, 7 achieved consensus with the expert panel. The goal of this process is to achieve consensus for each criteria either affirming (3.0 or higher) or rejecting it (2.0 or lower) for the study.

The following criteria achieved consensus by the panel participants affirming them for the study:

Criterion	Mean	SD
ICT systems implemented must include technology that is both available and accessible for classroom use by students and faculty (Caballe et al., 2010; Thomas, O'Bannon, & Bolton, 2013).	4.67	0.65
Faculty training for ICT system use must be available (Thomas, O'Bannon & Bolton, 2013; Toto et al., 2008; Roschelle et al., 2010).	4.92	0.29
Management or Administration of the institution must show support for ICT system use (Huda & Hussin, 2013; Huang et al., 2011).	4.75	0.45
The ICT system must be deliberately integrated into the pedagogy for the classroom (Caballe et al., 2010; Souleles et al., 2014; Murphy, 2011; Zurita et al., 2008; Alvarez et al., 2011; Chung, Kuo and Liu, 2010; Meurant, 2010; Wong & Li, 2008).	4.58	0.67
Faculty should have general technology self-efficacy (Ball & Levy, 2009; Huai, 2008; Roschelle et al., 2010).	4.25	0.62
Appropriate measurement of ICT system success must be in place prior to the system being implemented. (Piki, 2010)	4.33	0.78
Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009)	4.33	0.65

Using the online form at the link below, you will find the list of criteria from the first round that did not achieve consensus, along with participant feedback. As with the last round, please rate the impact of each criterion on implementing ICT in higher education on a 5-point Likert scale according to the table below:

Scale for Criteria Rating
5. Strongly Agree
4. Moderately Agree

3. Neutral
2. Moderately Disagree
1. Strongly Disagree

You will be asked for a short rationale for any criterion that you rate at less than 3. Criterion rated less than 3 will be considered insignificant for the development of the implementation model. Please see the link below for the second round of the study.

http://goo.gl/forms/hYLsxhGaKh

Thank you again for your willingness to participate in this study. If you have any questions about this process, please feel free to contact me.

Sincerely,
Thomas E Kurtz
Researcher

Appendix D

Second Round Instructions

Thank you for your first round responses. Of the 19 criteria that were rated, 7 achieved consensus with the expert panel. The goal of this process is to achieve consensus for each criterion either affirming (3.0 or higher) or rejecting it (2.0 or lower) for the study.

Here you will find the list of criteria from the first round that did not achieve consensus. You will first see participant feedback and researcher response, followed by the criterion in question. You will also see the mean (M) rating and standard deviation (SD) for each criteria from the last round. As with the last round, please rate the impact of each criterion on implementing ICT in higher education on a 5-point Likert scale according to the table below:

Scale for Criteria Rating
5. Strongly Agree
4. Moderately Agree
3. Neutral
2. Moderately Disagree
1. Strongly Disagree

You will be asked for a short rationale for any criterion that you rate at less than 3.

* Required

Criterion 1: Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010)

First Round Results: M = 4.5, SD = 1.17

Participant Feedback: My apologies, but the question is unclear. It appears to be saying the technology must match the requirements of the ICT? Not sure how to answer this.

Researcher feedback: This statement implies that the technology selected to implement the system has the ability to meet the needs of the intended use. For example, a laptop or tablet may work for an ICT system, but a smartphone may not have the full capabilities necessary to fully utilize the system. In this case, the system must exclude use of smartphones.

Criterion 1: Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 2: Teaching self-efficacy, or faculty perception of the capability to organize and execute actions in the classroom, must be high (Sang et al., 2010)

First Round Results: M = 4.25, SD = 0.97
Participant Feedback: Otherwise they may not engage or adapt to new changes. This should not be a barrier to implementation. I see these skills on a spectrum and I would not hold an implementation due to self-efficacy and capability being less than high. I would take a developmental perspective that allows faculty options for incremental implementation to build confidence and capacity. I might use one or the other for self-efficacy and capability. Organize and execute are two distinct actions. How should I evaluate if I am comfortable to organize but not execute.

Researcher Feedback: The research cited in this criterion identifies teaching self-efficacy as a barrier to implementation success, not just implementation. The research cites a distinct difference between ICT system implementation and ICT implementation success. The research states that low teaching self-efficacy must be mitigated for successful implementation.

Criterion 2: Teaching self-efficacy, or faculty perception of the capability to organize and execute actions in the classroom, must be high (Sang et al., 2010) *

	1	2	3	4	5	
Strongly Disagree						Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 3: Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010)

First Round Results: M = 3.92, SD = 1.08

Participant Feedback: I think this perception really comes down to how effective the institution has been in training and communicating with faculty. If faculty understand the theoretical and pedagogical implications and have been trained to build them into a purposeful educational framework, this is less of an issue. You may wish to explain what "Distraction and Detraction" mean in this context. Through acceptable use terms, having the expectation is valid. However, maybe not the most realistic in today's age.

Researcher feedback: For the context of this question, distraction should be related to the focus of a student being taken away from course material. Detraction should be thought of as loss of effectiveness or performance. Training and pedagogy can impact this criterion. You will find that many of the criteria in this study interrelate. For the context of this rating, focus should be put on this particular criterion's impact on an implementation model, not how the criterion can be mitigated.

Criterion 3: Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010) *

	1	2	3	4	5	

Strongly Disagree ◯ ◯ ◯ ◯ ◯ Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 4: Faculty should perceive usefulness or performance expectancy of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011)

First Round Results: M = 4.42, SD = 1.00

Participant Feedback: It is incumbent on the institution and administration to create these dynamics, however a lack of value perception cannot be a barrier to forward progress. Many times comfort and capacity come from exposure and use.

Researcher Feedback: There are many steps that can be taken to improve perceptions. As stated earlier, the focus should be put on the importance of this criteria for successful implementing ICT systems.

Criterion 4: Faculty should perceive usefulness or performance expectancy of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 5: Students should perceive usefulness or performance expectancy of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009)

First Round Results: M = 4.33, SD = 0.98

Participant Feedback: A student simply wants a system that works. Understanding what an LMS is capable of is (usefulness) is probably not the highest priority. Performance expectancy (uptime) is certainly something that should be an expectation. Does the question infer students should perceive usefulness prior to implementation? This may become self-evident as the technology is used but students may not be aware prior to use. I might split this into two statements. Usefulness and performance expectancy may be construed as two distinct concepts which makes responding a challenge

Researcher Feedback: For the context of this criterion, perceived usefulness and performance expectancy are synonymous. They both relate to the student's perception of usefulness of the implemented system. Student perception is at the time of first use.

Criterion 5: Students should perceive usefulness or performance expectancy of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009) *

1 2 3 4 5

Strongly Disagree ◯ ◯ ◯ ◯ ◯ Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 6: Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008)

First Round Results: M = 3.83, SD = 1.11

Participant Feedback: This is not to imply that the inclusion of ICT systems should not challenge students and push their skills however students should not hold the perception that it is a barrier to their learning. The need for ease of use may be tied to the level of the curriculum or the purpose the learning activity.

Researcher Feedback: For the context of this criterion, ease of use should be directly related to the use of the technology, not pedagogy or student learning resulting from use.

Criterion 6: Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 7: Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).

First Round Results: M = 3.75, SD = 0.97

Participant Feedback: The need for ease of use may be tied to the level of the curriculum or the purpose the learning activity. It may be helpful in many situations but not all. Perception is obviously relative - what one faculty may consider "easy", may not translate to other faculty. Contrary to my perspective on student perceptions I think that whether faculty perceive it to be easy or not is inconsequential. If and institution decides to drive ICT initiatives then it is incumbent on the faculty to develop those skills and the administration to provide those resources so that all involved are prepared and comfortable.

Researcher Feedback: For the context of this criterion, ease of use should be directly related to the use of the technology, not pedagogy or student learning resulting from use.

Criterion 7: Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011). *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 8: Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012)

First Round Results: M = 3.92, SD = 0.79

Participant Feedback: Students should be allowed to develop this.

Researcher Feedback: None.

Criterion 8: Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 9: Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010)

First Round Results: M = 3.0, SD = 0.60

Participant Feedback: Helpful not required A lot of these processes will be part of change for and institution. Some experience would be beneficial but should not be a barrier. Knowledge of or prior use are both 'nice to have' components. Should not be required for overall effectiveness or success for a student.

Researcher Feedback: None.

Criterion 9: Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 10: Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013)

First Round Results: M = 3.75, SD = 0.97

Participant Feedback: I am unclear what is meant by collaboration improvement.

Researcher Feedback: The perception of collaboration improvement directly relates to the student's feeling of the increase in interaction with other students and the faculty member.

Criterion 10: Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 11: Lower effort expectancy will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)

First Round Results: M = 3.25, SD = 0.75

Participant Feedback: Lower effort expectancy of student and faculty?? Whose effort?? Is this for students or faculty or both? I wasn't clear on this question and the perspective of low effort. If the students feel that in using the ICT they will need to give less effort then the overall student learning will suffer meaning a less successful implementation.

Researcher Feedback: To clarify the question, I will separate faculty and student into two separate criteria.

Criterion 11A: Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 11B: Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 12: Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)

First Round Results: M = 3.5, SD = 0.90
Participant Feedback: This is an antiquated way of thinking about this. A good deal of research points towards a normalization of skills set which did previously favor younger generations however we continue to age out of those dynamics and capacity in general is seen to be on the rise.

Researcher Feedback: There is research that both supports and rejects age as a construct of system use. This expert panel should consider age being a construct purely within the environment of higher education, specifically students and faculty.

Criterion 12: Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Suggestions for Additional Criteria

Participant Feedback: I might suggest some items about communication systems. I feel like these are eluded to but you may want to know about perception on the importance of structured communication students for all stakeholders. Just generally, I would also encourage you to make sure each statement only evaluates one item. There were a few items that had "and" statements which indicates a measure of two distinct items through a single question. take a look to be sure that the data you get backs allows you to make clear conclusions about each item you wish to evaluate.

Researcher Feedback: The term 'Information and Communication Technology (ICT)' is inclusive of all systems that improve collaboration, communication and information sharing. It is the intent of this study that communication systems are inclusive within ICT learning systems. The statements that were noted as confusing with 'and' or 'or' have been clarified in researcher feedback or have been separated into new statements.

Appendix E

Invitation Letter

Dear ,

This letter is an invitation to participate in an expert panel discussion for the development of an implementation model for Information and Communication Technology (ICT) in higher education. You have been asked to participate in this study due to your position as a full time faculty member, technology implementer, or higher education administrator. These roles directly impacted by the use of ICT systems in higher education.

Using the Delphi method for expert consensus, this group will review and validate a list of evaluation criteria for ICT implementation. The Delphi method uses an iterative approach to generate, evaluate and gain consensus among the expert panel participants. The process will consist of three or more rounds of questioning via email communication over the next three months.

For the first round of the study, you will be presented with an initial list of implementation criteria and be given the opportunity to suggest additional items. For each subsequent round, the criteria will be further developed until group consensus is reached on a final list of implementation criteria. The researcher will then develop and propose an implementation model based upon the results of this expert panel. After the creation of the proposed model, this expert panel will be reconvened in order to evaluate the efficacy of the model to satisfy each criterion in the list.

Your willingness to participate in this study would be greatly appreciated. If you wish to participate in this study, please reply to this email indicating so. If you do not wish to participate, please also reply indicating your request to be excluded.

Thank you,

Thomas E Kurtz
Researcher

Appendix F

Summative Panel Instructions

Implementation Model Evaluation

Dear Expert Panel Participants,

Thank you for your interest in participating in this research study. As a recap from the initial invitation several weeks ago, you have volunteered to participate in an expert panel to evaluate an implementation model for Information and Communication Technology (ICT) systems in higher education. The following processes have taken place prior to your involvement in the study:

1. An expert panel was convened to determine a list of criteria that should be satisfied by an implementation model.

2. The researcher developed the implementation model to satisfy the criteria developed by the expert panel.

3. The expert panel was reconvened to pre-evaluate the model developed by the researcher and suggest modifications.

The next phase of the project is to have the implementation model evaluated by a separate three-member expert panel that has no prior interaction with the research.

Using the online form at the link below, you will find the list of criteria developed by the expert panel. The criteria are separated into the categories of Technology Selection, Administration Support, Faculty Technology Acceptance, Student Technology Acceptance, and Pedagogy Integration. Attached to this email is the implementation model developed by the researcher to satisfy the given criteria.

Using the scale below, please rate the implementation model on its ability to satisfy the given criteria.
Scale for Criteria Rating
5. Strongly Agree
4. Moderately Agree
3. Neutral
2. Moderately Disagree
1. Strongly Disagree

Your rating should be based upon your opinion of how the implementation model satisfies the given criteria, not rating the importance of the criteria itself. The establishment of the criteria was in the scope of the previous panel. You will be able to provide qualitative feedback for each criteria as well.

http://goo.gl/forms/qaS0juuBbk

Thank you again for your willingness to participate in this study. Please try to complete this survey by Wednesday, July 15th. If you are unable to compete the survey by that date, please let me know as soon as you are able.

Sincerely,

Tom Kurtz
Researcher
* Required

Technology Selection Criteria

ICT systems implemented must include technology that is both available and accessible for classroom use by students and faculty (Caballe et al., 2010; Thomas, O'Bannon, & Bolton, 2013). *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Administrative Support Criteria

Faculty training for ICT system use must be available (Thomas, O'Bannon & Bolton, 2013; Toto et al., 2008; Roschelle et al., 2010). *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Management or Administration of the institution must show support for ICT system use (Huda & Hussin, 2013; Huang et al., 2011). *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Appropriate measurement of ICT system success must be in place prior to the system being implemented. (Piki, 2010) *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Comments

Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010) *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Comments

Faculty Technology Acceptance Criteria

Faculty should perceive usefulness or performance expectancy of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011) *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Comments

Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011). *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Comments

Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Comments

Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Comments

Faculty should have general technology self-efficacy (Ball & Levy, 2009; Huai, 2008; Roschelle et al., 2010). *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Student Technology Acceptance Criteria

Students should perceive usefulness or performance expectancy of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012) *

1 2 3 4 5

Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Pedagogy Integration Criteria

The ICT system must be deliberately integrated into the pedagogy for the classroom (Caballe et al., 2010; Souleles et al., 2014; Murphy, 2011; Zurita et al., 2008; Alvarez et al., 2011; Chung, Kuo and Liu, 2010; Meurant, 2010; Wong & Li, 2008). *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Teaching self-efficacy, or faculty perception of the capability to organize and execute actions in the classroom, must be high (Sang et al., 2010) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Comments

Appendix G

Nova Southeastern University IRB Approval

Appendix H

Baker College IRB Approval

Baker College
Since 1911

Baker College System Headquarters
1050 West Bristol Road
Flint, Michigan 48507
Telephone (810) 766-4280
Fax (810) 766-4279
Internet: www.baker.edu

Protocol ID # 14-26
Please refer to this Protocol ID number in all communications about this project with the IRB.

TO: Thomas Kurtz

FROM: Institutional Review Board

DATE: January 14, 2015

RE: Approaches for developing a model for information and communication technology (ICT) implementation in the higher education environment.

Thank you for your submission of the above named protocol. The project has been identified as exempt under guidelines provided by rule of Health and Human Services. Please note that it is the researcher's responsibility to ensure that data is collected and maintained in a manner that meets the established criteria. No changes in procedure or documentation should be made without consultation with the IRB. Changes to procedures may require the project to be resubmitted under a different category.

This project has been approved in its current form for one year from 1-14-2015. If the project extends beyond this date, a request for modification must be submitted no later than 30 days prior to the above date. Please remember that any changes to the protocol will require the submission of a revised protocol to the IRB. Any adverse reaction by a research subject is to be reported immediately to the Chair of the IRB through the Office of Institutional Effectiveness, Baker College, at 810-766-4329 or via e-mail at irb@baker.edu.

Questions concerning the IRB decision or any concerns may be directed to the IRB Chair, through Dr. Michael Tyler, Associate Vice President of Institutional Effectiveness.

Appendix I

Third Round Instructions

Thank you for your second round responses. Of the 13 criteria that were rated, 2 achieved consensus with the expert panel. The goal of this process is to achieve consensus for each criterion either affirming (3.0 or higher) or rejecting it (2.0 or lower) for the study.

Here you will find the list of criteria from the second round that did not achieve consensus. You will first see participant feedback and researcher response, followed by the criterion in question. You will also see the mean (M) rating and standard deviation (SD) for each criteria from the last round. As with the last round, please rate the impact of each criterion on implementing ICT in higher education on a 5-point Likert scale according to the table below:

Scale for Criteria Rating
5. Strongly Agree
4. Moderately Agree
3. Neutral
2. Moderately Disagree
1. Strongly Disagree

You will be asked for a short rationale for any criterion that you rate at less than 3.
Please complete this form by Monday, February 16th.
Thank you,
Tom Kurtz
* Required

Criterion 1: Teaching self-efficacy, or faculty perception of the capability to execute actions in the classroom, must be high (Sang et al., 2010)
First Round Results: M = 4.25, SD = 0.97
Second Round Results: M = 4.09, SD = 0.94

Participant Feedback Round One: Otherwise they may not engage or adapt to new changes. This should not be a barrier to implementation. I see these skills on a spectrum and I would not hold an implementation due to self-efficacy and capability being less than high. I would take a developmental perspective that allows faculty options for incremental implementation to build confidence and capacity. I might use one or the other for self-efficacy and capability. Organize and execute are two distinct actions. How should I evaluate if I am comfortable to organize but not execute.

Researcher Feedback Round One: The research cited in this criterion identifies teaching self-efficacy as a barrier to implementation success, not just implementation. The research cites a distinct difference between ICT system implementation and ICT implementation success. The research states that low teaching self-efficacy must be mitigated for successful implementation.

Participant Feedback Round Two: I believe the participant feedback is still relevant. Even considering implementation and success as two different things...organizing and executing are also two separate concepts. Have difficulty answering the questions. As defined in the response from the researcher I would agree with this though not without reservation.

Researcher Feedback Round Two: The reservations are understandable, and they are noted in the literature. Teaching self-efficacy has been shown to be statistically significant in ICT system implementation success, however most of the studies have been in the secondary education realm. Also, to make the statement more concise and to align with the literature, I have removed the word 'organize' and only list 'execute' in this statement. The execution of teaching is the most important piece related to ICT system implementation.

Criterion 1: Teaching self-efficacy, or faculty perception of the capability to organize and execute actions in the classroom, must be high (Sang et al., 2010) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 2: Faculty should perceive usefulness of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011)

First Round Results: M = 4.42, SD = 1.00
Second Round Results: M = 4.45, SD = 1.03

Participant Feedback Round One: It is incumbent on the institution and administration to create these dynamics, however a lack of value perception cannot be a barrier to forward progress. Many times comfort and capacity come from exposure and use.

Researcher Feedback Round One: There are many steps that can be taken to improve perceptions. As stated earlier, the focus should be put on the importance of this criteria for successful implementing ICT systems.

Participant Feedback Round Two: No, with a well structured system this should not matter.

Researcher Feedback Round Two: As 'perceived usefulness' is the most common term in technology acceptance research, I have modified the wording of the statement to only include that element. This statement is really asking if the implementation model for the system should include an element that shows the user the benefit of using the system. That is how the perception of usefulness is established. If understanding the benefit of the system is not important, than the implementation model does not need to educate the user on its importance.

Criterion 2: Faculty should perceive usefulness or performance expectancy of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 3: Students should perceive usefulness of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009)

First Round Results: M = 4.33, SD = 0.98
Second Round Results: M = 4.0, SD = 0.89

Participant Feedback Round One: A student simply wants a system that works. Understanding what an LMS is capable of is (usefulness) is probably not the highest priority. Performance expectancy (uptime) is certainly something that should be an expectation. Does the question infer students should perceive usefulness prior to implementation? This may become self-evident as the technology is used but students may not be aware prior to use. I might split this into two statements. Usefulness and performance expectancy may be construed as two distinct concepts which makes responding a challenge

Researcher Feedback Round One: For the context of this criterion, perceived usefulness and performance expectancy are synonymous. They both relate to the student's perception of usefulness of the implemented system. Student perception is at the time of first use.

Participant Feedback Round Two: I can not answer this as usefulness and performance expectancy are not synonymous in my experience. My response would not be valid as I can not agree with that definition. At time of first use I don't know they will.

Researcher Feedback Round Two: As 'perceived usefulness' is the most common term in technology acceptance research, I have modified the wording of the statement to only include that element. This statement is really asking if the implementation model for the system should include an element that shows the user the benefit of using the system. That is how the perception of usefulness is established. If understanding the benefit of the system is not important, than the implementation model does not need to educate the user on its importance.

Criterion 3: Students should perceive usefulness or performance expectancy of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 4: Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008)

First Round Results: M = 3.83, SD = 1.11
Second Round Results: M = 3.82, SD = 0.87

Participant Feedback Round One: This is not to imply that the inclusion of ICT systems should not challenge students and push their skills however students should not hold the perception that it is a barrier to their learning. The need for ease of use may be tied to the level of the curriculum or the purpose the learning activity.

Researcher Feedback Round One: For the context of this criterion, ease of use should be directly related to the use of the technology, not pedagogy or student learning resulting from use.

Participant Feedback Round Two: While always pleasant, I don't believe this student perception is a requirement.

Researcher Feedback Round Two: Ease of use is a core construct in the Technology Acceptance Model by Davis (1989). The studies cited in criterion 4 identify ease of use to be a determinant specifically in educational settings. The Uniform Theory of Acceptance and Use of Technology (UTAUT) has shown that 'Effort Expectancy' is a better determinant of system use than 'Ease of Use'. The literature review for this study found that studies in ICT implementation in education have referred to either Ease of Use or Effort Expectancy. That is why both are listed separately. Criteria #4 and #5 use Ease of Use and #9 and #10 use Performance Expectancy.

Criterion 4: Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 5: Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).
First Round Results: M = 3.75, SD = 0.97
Second Round Results: M = 3.82, SD = 0.98

Participant Feedback Round One: The need for ease of use may be tied to the level of the curriculum or the purpose the learning activity. It may be helpful in many situations but not all. Perception is obviously relative - what one faculty may consider "easy", may not translate to other faculty. Contrary to my perspective on student perceptions I think that whether faculty perceive it to be easy or not is inconsequential. If and institution decides to drive ICT initiatives then it is incumbent on the faculty to develop those skills and the administration to provide those resources so that all involved are prepared and comfortable.

Researcher Feedback Round One: For the context of this criterion, ease of use should be directly related to the use of the technology, not pedagogy or student learning resulting from use.

Participant Feedback Round Two: The researcher feedback does not alter my rating or opinion.

Researcher Feedback Round Two: Ease of use is a core construct in the Technology Acceptance Model by Davis (1989). The studies cited in criterion 4 identify ease of use to be a determinant specifically in educational settings. The Uniform Theory of Acceptance and Use of Technology (UTAUT) has shown that 'Effort Expectancy' is a better determinant of system use than 'Ease of Use'. The literature review for this study found that studies in ICT implementation in education have referred to either Ease of Use or Effort Expectancy. That is why both are listed separately. Criteria #4 and #5 use Ease of Use and #9 and #10 use Performance Expectancy.

Criterion 5: Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011). *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 6: Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012)
First Round Results: M = 3.92, SD = 0.79
Second Round Results: M = 3.55, SD = 0.93

Participant Feedback Round One: Students should be allowed to develop this.

Participant Feedback Round Two: No additional information provided. Assume the purpose of the ICT initiative is to build this in some way.

Researcher Feedback: The purpose of the ICT initiative is to ultimately improve student learning in the classroom. The intent of the system is not to improve a students' technology self-efficacy. Technology self-efficacy, or one's belief in their own technology skills, has been shown by the

studies listed above as a predictor of system use and acceptance. The rating of this criterion should be related to the importance of the implementation model to address technology self-efficacy of students prior to system use.
Criterion 6: Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 7: Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010)

First Round Results: M = 3.0, SD = 0.60
Second Round Results: M = 3.27, SD = 0.90

Participant Feedback Round One: Helpful not required A lot of these processes will be part of change for and institution. Some experience would be beneficial but should not be a barrier. Knowledge of or prior use are both 'nice to have' components. Should not be required for overall effectiveness or success for a student.

Participant Feedback Round Two: Specific knowledge of the specific ICT system should not be a requirement in advance of use. General familiarity with technology would be helpful. Without prior exposure / knowledge, students can waste valuable time learning the in's and outs of a system as opposed to learning content. Researcher feedback did not change my response.

Researcher Feedback: General familiarity with technology would more likely be addressed in the previous criterion (technology self-efficacy). This statement relates to a users experience to the specific technology used in the ICT system implementation. You will notice that this is one of the lower rated criterion. One of the participants noted that this shouldn't be a requirement. The rating of this criterion should be if this is a required criterion for an implementation model.

Criterion 7: Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 8: Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O’Bannon, & Bolton, 2013)
First Round Results: M = 3.75, SD = 0.97
Second Round Results: M = 3.66, SD = 0.81

Participant Feedback Round One: I am unclear what is meant by collaboration improvement.

Researcher Feedback Round One: The perception of collaboration improvement directly relates to the student's feeling of the increase in interaction with other students and the faculty member.

Participant Feedback Round Two: Many ICT systems do not have an impact on collaboration. If so - student or faculty perception of this become irrelevant.

Researcher Feedback Round Two: Research has shown that collaborative learning, or computer supported collaborative learning (CSCL) is statistically significant in improving student learning in the classroom. Information and Communication Technology (ICT) systems have collaboration as an element within them. Simpler technology, like audience response systems, that don't have an element of collaboration would not be considered an ICT system for the scope of this study.

Criterion 8: Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 9: Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)

First Round Results: M = 3.25, SD = 0.75
Second Round Results: M = 3.64, SD = 0.92

Participant Feedback Round One: Lower effort expectancy of student and faculty?? Whose effort?? Is this for students or faculty or both? I wasn't clear on this question and the perspective of low effort. If the students feel that in using the ICT they will need to give less effort then the overall student learning will suffer meaning a less successful implementation. Researcher

Feedback Round One: To clarify the question, I will separate faculty and student into two separate criteria.

Participant Feedback Round Two: Lower effort required on the part of faculty and students will increase success of implementation. could be related to 'ease of use' I do not think lowering this bar in any way helps implementation- if I understand the statement correctly

Researcher Feedback Round Two: Effort expectancy is the level of effort expected to occur to use the system. That effort could be a technology learning curve, in this case. Ease of use is a core construct in the Technology Acceptance Model by Davis (1989). The Uniform Theory of Acceptance and Use of Technology (UTAUT) has shown that 'Effort Expectancy' is a better determinant of system use than 'Ease of Use'. The literature review for this study found that studies in ICT implementation in education have referred to either Ease of Use or Effort Expectancy. That is why both are listed separately. Criteria #4 and #5 use Ease of Use and #9 and #10 use Performance Expectancy.

Criterion 9: Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 10: Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)
First Round Results: M = 3.25, SD = 0.75
Second Round Results: M = 3.55, SD = 0.82

Participant Feedback Round One: Lower effort expectancy of student and faculty?? Whose effort?? Is this for students or faculty or both? I wasn't clear on this question and the perspective of low effort. If the students feel that in using the ICT they will need to give less effort then the overall student learning will suffer meaning a less successful implementation.

Researcher Feedback Round One: To clarify the question, I will separate faculty and student into two separate criteria.

Participant Feedback Round Two: I still feel student learning could suffer if their expectations don't match the rigor required. These expectations may help with the initial implementation but if success is measured by student learning in the long run, then I disagree.

Researcher Feedback Round Two: Ease of use is a core construct in the Technology Acceptance Model by Davis (1989). The Uniform Theory of Acceptance and Use of Technology (UTAUT) has shown that 'Effort Expectancy' is a better determinant of system use than 'Ease of Use'. The literature review for this study found that studies in ICT implementation in education have referred to either Ease of Use or Effort Expectancy. That is why both are listed separately. Criteria #4 and #5 use Ease of Use and #9 and #10 use Performance Expectancy.

Criterion 10: Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 11: Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)
First Round Results: M = 3.5, SD = 0.90
Second Round Results: M = 3.45, SD: 1.04

Participant Feedback Round One: This is an antiquated way of thinking about this. A good deal of research points towards a normalization of skills set which did previously favor younger generations however we continue to age out of those dynamics and capacity in general is seen to be on the rise.

Researcher Feedback Round One: There is research that both supports and rejects age as a construct of system use. This expert panel should consider age being a construct purely within the environment of higher education, specifically students and faculty.

Participant Feedback Round Two: Age disparity in user resistance is diminishing. Proof is in the pudding. While older users are indeed improving technical savvy, there's still a long ways to go before the majority are not resistant. Researcher feedback did not alter my rating. I would want to evaluate this during the study but do not agree with the statement. The two studies cited are now close to six years old which is a concern.

Researcher Feedback Round Two: I would agree anecdotally that age is less of a factor in technology use. That being said, the studies above in educational settings have shown that it is still a determinant. While being 6 years old, more recent studies in non-educational settings still show age as a factor of the UTAUT model. The Uniform Theory of Acceptance and Use of Technology (UTAUT) shows that age is not a direct factor for behavioral intention to use technology, but it is a factor in determining effort expectancy, social influence, and performance expectancy of system use.

Criterion 11: Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Appendix J

Fourth Round Instructions

Thank you for your third round responses. Of the 11 criteria that were rated, 6 achieved consensus with the expert panel. Here you will find the list of criteria from the second round that did not achieve consensus. You will first see participant feedback and researcher response, followed by the criterion in question. You will also see the mean (M) rating and standard deviation (SD) for each criteria from the last round. As with the last round, please rate the impact of each criterion on implementing ICT in higher education on a 5-point Likert scale according to the table below:

Scale for Criteria Rating
5. Strongly Agree
4. Moderately Agree
3. Neutral
2. Moderately Disagree
1. Strongly Disagree

You will be asked for a short rationale for any criterion that you rate at less than 3.
Please complete this form by Friday, March 6th.
Thank you,
Tom Kurtz
* Required

For criteria that do not achieve consensus of the expert panel after this round, how would you like to proceed? *

- ◯ Reject all remaining criteria for the study.
- ◯ Accept all remaining criteria for the study
- ◯ Reject criteria with Mean of less than 3.0
- ◯ Proceed for an additional round as done with rounds 1-4
- ◯ Other: ☐

Criterion 1: Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008)

First Round Results: M = 3.83, SD = 1.11
Second Round Results: M = 3.82, SD = 0.87
Third Round Results: M = 4.09, SD = 0.94

Participant Feedback Round One: This is not to imply that the inclusion of ICT systems should not challenge students and push their skills however students should not hold the perception that it is a barrier to their learning. The need for ease of use may be tied to the level of the curriculum or the purpose the learning activity.

Researcher Feedback Round One: For the context of this criterion, ease of use should be directly related to the use of the technology, not pedagogy or student learning resulting from use.

Participant Feedback Round Two: While always pleasant, I don't believe this student perception is a requirement.

Researcher Feedback Round Two: Ease of use is a core construct in the Technology Acceptance Model by Davis (1989). The studies cited in criterion 4 identify ease of use to be a determinant specifically in educational settings. The Uniform Theory of Acceptance and Use of Technology (UTAUT) has shown that 'Effort Expectancy' is a better determinant of system use than 'Ease of Use'. The literature review for this study found that studies in ICT implementation in education have referred to either Ease of Use or Effort Expectancy. That is why both are listed separately. Criteria #4 and #5 use Ease of Use and #9 and #10 use Performance Expectancy.

Participant Feedback Round Three: My experience has been that this is beneficial but not required. As such, my rating is 2.

Criterion 1: Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 2: Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).

First Round Results: M = 3.75, SD = 0.97
Second Round Results: M = 3.82, SD = 0.98
Third Round Results: M = 4.0, SD = 1.0

Participant Feedback Round One: The need for ease of use may be tied to the level of the curriculum or the purpose the learning activity. It may be helpful in many situations but not all. Perception is obviously relative - what one faculty may consider "easy", may not translate to other faculty. Contrary to my perspective on student perceptions I think that whether faculty perceive it to be easy or not is inconsequential. If and institution decides to drive ICT initiatives then it is incumbent on the faculty to develop those skills and the administration to provide those resources so that all involved are prepared and comfortable.

Researcher Feedback Round One: For the context of this criterion, ease of use should be directly related to the use of the technology, not pedagogy or student learning resulting from use.

Participant Feedback Round Two: The researcher feedback does not alter my rating or opinion.

Researcher Feedback Round Two: Ease of use is a core construct in the Technology Acceptance Model by Davis (1989). The studies cited in criterion 4 identify ease of use to be a determinant specifically in educational settings. The Uniform Theory of Acceptance and Use of Technology (UTAUT) has shown that 'Effort Expectancy' is a better determinant of system use than 'Ease of Use'. The literature review for this study found that studies in ICT implementation in education have referred to either Ease of Use or Effort Expectancy. That is why both are listed separately. Criteria #4 and #5 use Ease of Use and #9 and #10 use Performance Expectancy.

Participant Feedback Round Three: I appreciate the research supporting the statement, however on a scale of 1 - 5, my opinion is reflected by the rating.

Criterion 2: Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011). *

1 2 3 4 5

Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 3: Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010)

First Round Results: M = 3.0, SD = 0.60
Second Round Results: M = 3.27, SD = 0.90
Third Round Results: M = 3.55, SD = 0.82

Participant Feedback Round One: Helpful not required A lot of these processes will be part of change for and institution. Some experience would be beneficial but should not be a barrier. Knowledge of or prior use are both 'nice to have' components. Should not be required for overall effectiveness or success for a student.

Participant Feedback Round Two: Specific knowledge of the specific ICT system should not be a requirement in advance of use. General familiarity with technology would be helpful. Without prior exposure / knowledge, students can waste valuable time learning the in's and outs of a system as opposed to learning content. Researcher feedback did not change my response.

Researcher Feedback: General familiarity with technology would more likely be addressed in the previous criterion (technology self-efficacy). This statement relates to a users experience to the specific technology used in the ICT system implementation. You will notice that this is one of the lower rated criterion. One of the participants noted that this shouldn't be a requirement. The rating of this criterion should be if this is a required criterion for an implementation model.

Participant Feedback Round Three: I don't believe this is a requirement. My thought is that some sort of orientation to the ICT system should be in place and completed by students prior to taking a course using the technology.

Criterion 3: Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010) *

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 4: Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O’Bannon, & Bolton, 2013)

First Round Results: M = 3.75, SD = 0.97
Second Round Results: M = 3.66, SD = 0.81
Third Round Results: M = 3.91, SD = 0.94

Participant Feedback Round One: I am unclear what is meant by collaboration improvement.

Researcher Feedback Round One: The perception of collaboration improvement directly relates to the student's feeling of the increase in interaction with other students and the faculty member.

Participant Feedback Round Two: Many ICT systems do not have an impact on collaboration. If so student or faculty perception of this become irrelevant.

Researcher Feedback Round Two: Research has shown that collaborative learning, or computer supported collaborative learning (CSCL) is statistically significant in improving student learning in the classroom. Information and Communication Technology (ICT) systems have collaboration as an element within them. Simpler technology, like audience response systems, that don't have an element of collaboration would not be considered an ICT system for the scope of this study.

Participant Feedback Round Three: Collaborative learning can significantly impact student learning - the perception of the impact of collaboration is less important.

Criterion 4: Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O’Bannon, & Bolton, 2013) *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Criterion 5: Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)

First Round Results: M = 3.5, SD = 0.90
Second Round Results: M = 3.45, SD: 1.04
Third Round Results: M = 3.35, SD = 0.92

Participant Feedback Round One: This is an antiquated way of thinking about this. A good deal of research points towards a normalization of skills set which did previously favor younger generations however we continue to age out of those dynamics and capacity in general is seen to be on the rise.

Researcher Feedback Round One: There is research that both supports and rejects age as a construct of system use. This expert panel should consider age being a construct purely within the environment of higher education, specifically students and faculty.

Participant Feedback Round Two: Age disparity in user resistance is diminishing. Proof is in the pudding. While older users are indeed improving technical savvy, there's still a long ways to go before the majority are not resistant. Researcher feedback did not alter my rating. I would want to evaluate this during the study but do not agree with the statement. The two studies cited are now close to six years old which is a concern.

Researcher Feedback Round Two: I would agree anecdotally that age is less of a factor in technology use. That being said, the studies above in educational settings have shown that it is still a determinant. While being 6 years old, more recent studies in non-educational settings still show age as a factor of the UTAUT model. The Uniform Theory of Acceptance and Use of Technology (UTAUT) shows that age is not a direct factor for behavioral intention to use technology, but it is a factor in determining effort expectancy, social influence, and peformance expectancy of system use.

Participant Feedback Round Three: My experiences drive me to the rating of 2.

Criterion 5: Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009) *

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Please put your rationale for a rating below 3 for the above criterion.

Appendix K

Final Criteria List

The final criteria for the study are listed below. The criteria reflect all wording changes suggested by the expert panel. The mean and standard deviation for each criterion is listed.

1. ICT systems implemented must include technology that is both available and accessible for classroom use by students and faculty (Caballe et al., 2010; Thomas, O'Bannon, & Bolton, 2013). (M=4.67, SD=0.65)

2. Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010). (M=4.55, SD=0.82)

3. Faculty training for ICT system use must be available (Thomas, O'Bannon & Bolton, 2013; Toto et al., 2008; Roschelle et al., 2010). (M=4.92, SD=0.29)

4. Management or Administration of the institution must show support for ICT system use (Huda & Hussin, 2013; Huang et al., 2011). (M=4.75, SD=0.45)

5. The ICT system must be deliberately integrated into the pedagogy for the classroom (Caballe et al., 2010; Souleles et al., 2014; Murphy, 2011; Zurita et al., 2008; Alvarez et al., 2011; Chung, Kuo and Liu, 2010; Meurant, 2010; Wong & Li, 2008). (M=4.58, SD=0.67)

6. Teaching self-efficacy, or faculty perception of the capability to execute actions in the classroom, must be high (Sang et al., 2010). (M=4.18, SD=0.75)

7. Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010). (M=3.82, SD=0.60)

8. Faculty should perceive usefulness of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011). (M=4.18, SD=0.75)

9. Students should perceive usefulness of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009). (M=4.18, SD=0.75)

10. Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008). (M=3.91, SD=0.83)

11. Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011). (M=3.82, SD=0.87)

12. Faculty should have general technology self-efficacy (Ball & Levy, 2009; Huai, 2008; Roschelle et al., 2010). (M=4.25, SD=0.62)

13. Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012). (M=4.00, SD=0.45)

14. Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010). (M=3.27, SD=0.79)

15. Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013) (M=3.67, SD=0.67)

16. Appropriate measurement of ICT system success must be in place prior to the system being implemented. (Piki, 2010) (M=4.33, SD=0.78)

17. Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009). (M=4.33, SD=0.65)

18a. Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009). (M=3.64, SD=0.81)

18b. Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009). (M=3.82, SD=0.87)

19. Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009) (M=3.64, SD=1.03)

Appendix L

Implementation Model

Implementation Model for Information and Communication Technology (ICT) in the Higher Education Environment

by

Thomas E. Kurtz

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2015

Model Table of Contents

Implementation Model for Information and Communication Technology (ICT) in the Higher Education Environment

Introduction

This model develops strategies for the implementation of Information and Communication Technology (ICT) system use in the higher education environment. The model is designed around a set of criteria that was developed by technology implementers, faculty and higher education administrators through the use of an expert panel process. The criteria include elements that were considered significant for system implementation success by the expert panel (see Appendix A). The criteria and model creation are focused on an approach that can be applied to a broad range of higher education environments.

The criteria established by the expert panel are grouped into smaller categories in order to appropriately address the implementation characteristics for each criterion. The criteria have been separated into technology selection, administration support, faculty technology acceptance, student technology acceptance and pedagogy integration categories. Implementation approaches and potential measurements of implementation success will be presented for each criteria category.

Technology Selection

The criteria included in this category pertain directly to the specific technology chosen for use with the ICT system. As shown in Appendix A, the criteria in this category state that the technology chosen should be both available and accessible by students and faculty. The technology should also have the hardware and software capabilities to accomplish the tasks that the ICT system is intended to perform. The users of the technology should have prior experience with the technology or a familiarity with its use.

Approaches for Implementation

ICT systems must have a defined set of requirements for the specific technology used in the system. With the pervasiveness of devices used by student and faculty users, it is important to identify what hardware and software requirements are necessary for system use. Many past ICT system implementations have encountered challenges when trying to implement less robust technologies with small form factor displays and limited input capacity, like smartphones and other mobile devices. The ICT system must be carefully designed to accommodate the input, display and other hardware requirements of the devices used to implement the system. A clear set of technology requirements should be included with the system to ensure that the devices available to the users can appropriately use the ICT system.

Access and funding technology availability are significant barriers to ICT system implementation. While these barriers are breaking down by the ubiquity of smartphone and other mobile devices in the classroom, the implementers of the ICT system must ensure that access to the technology is available to all system users. When developing an ICT system, designers need to include mechanisms for access to the technology. These mechanisms can include providing students with the technology through lab environments or creating ‘check out’ and rental processes for those users who don’t already possess a compatible device.

Users of the ICT system should have prior experience or a familiarity with the technology selected for use in the ICT system. Having a theoretical or conceptual understanding of technology use does not satisfy this requirement. Users need to have a hands on approach to the use of the specified technology before the impact of the ICT system can be fully realized. Users should be familiar with the core functionality of the technology, especially user interfaces and input methods. This experience with the technology can be accomplished in several ways. Technology that has been used previously by the users of the ICT system could be selected for use within the system. Alternatively, the development of a deliberate training or professional development process can satisfy this design requirement. Training content can vary greatly based upon the technology selected for the ICT system but should include instruction on interaction and usability of the specific technology.

Measurement of Criteria

To measure the ability for the ICT system implementation to meet the criteria in this category, the following components are necessary:

1. Technology hardware and software requirements documentation to include a combination of the following topics. A sample requirements document is included in Appendix B.
    a. Processor
    b. Memory/Storage Capacity
    c. Input method (touch screen, keyboard, mouse, etc.)
    d. Minimum display size

e. Operating System(s)

f. Software/App requirements

2. A plan for technology access for all users of the ICT system, which can include the following examples:

    a. Provided in a lab environment

    b. Check out process

    c. Rental or Purchase program

3. A training model for the technology use

Administration Support

The administrative support category of criteria establishes the role of administrators within ICT system implementation. As stated in the criteria and affirmed by the expert panel, administration has a large role in ICT system implementation. Administrators and managers must show support for the use of ICT system implementation as they are ultimately the decision makers and understand time and financial resource investments. Part of that support is providing the opportunity for training and professional development for faculty. The administration must reinforce the goals and drivers for use of technology in the classroom in order to reduce the perception of detraction from the learning environment and expand the perception of usefulness. Appropriate measures for ICT system success must be defined and in place before ICT systems are integrated into the higher education environment as well.

Approaches for Implementation

Strong governance structures that emphasize the use of ICT system in supporting student learning should be established as part of the project implementation process. The administrative support is necessary to establish value in system implementation and reinforce the higher education institution's commitment of time and financial resources. The lack of strong administrative support causes users to believe the system to be a passing trend and reduces perceived usefulness. The establishment of strong administrative support and governance structures contribute to a culture or climate that encourages innovation.

The establishment and implementation of any ICT system should be based upon a set of goals. Administrators, governance, and other key stakeholders of the system need to develop clear, objective goals for ICT system use. Technology alone is not a sole contributor to any learning initiative. The goals could include measures of student learning improvement, collaboration improvement, student engagement, or other appropriate measures of system success. The introduction of technology into the classroom may also have a negative impression on student learning improvement due to the potential uses unrelated to classroom activity. Having established goals for system implementation that effectively show potential for improvement reduces the perception of distraction or detraction from educational activities because of the introduction of technology usage in the classroom. Examples of appropriate and intended use should be incorporated into the goals and technology use policy. The creation of a technology use policy that clarifies that technology should not be used for purposes unrelated to classroom activities can also reduce the perceived distraction by faculty.

Administrative support is also established through providing time and financial support for training users of the ICT system. Quality training can be costly and time intensive, but is necessary to increase success in ICT system implementation. Training also should not be only front-loaded, training and support for the ICT system should be provided on an as-needed basis throughout ICT system use.

Measurement of Criteria

To measure the ability for the ICT system implementation to meet the criteria in this category, the following components are necessary:

1. Creation of ICT governance structure including faculty, administrator, and information technology representation.
2. Established goals for system implementation, which may include the following examples:
    a. Student learning/performance improvement
    b. Student and faculty collaboration improvement
    c. Student classroom engagement improvement
3. Creation of a technology use policy. An example is listed in Appendix C.
4. Quantity and quality of ICT system training available for users.

Faculty Technology Acceptance

The faculty technology acceptance category identifies criteria related to several constructs in technology acceptance research. The constructs of perceived usefulness, performance expectancy, perceived ease of use, social influence, age and self-efficacy were all identified by the expert panel as significant to the development of an implementation model. Faculty support is crucial since individual faculty influence peers in the use of ICT systems. Faculty should find the ICT system easy to use and have lower effort expectancy. Faculty should also perceive that the ICT system is useful in the classroom environment. Faculty age was also noted as a factor for resistance to use technology by the expert panel.

Approaches for Implementation

Performance expectancy, or the perception that the ICT system will perform a value added task, is vital for faculty technology acceptance. Faculty usage of technology increases with the perception of usefulness that the ICT system provides. As stated in the administrative support section, there needs to be a focused approach in outlining the reason behind the implementation of ICT systems and the usefulness they provide. Support of those goals, including prior research and user testimonials, would provide evidence to strengthen the goals. A clear definition of the purpose of ICT system implementation is necessary to share with faculty the expected performance of the system.

The technology implemented in the ICT should also be perceived as easy to use by faculty. Ease of use is not directly tied with faculty acceptance and use of technology, but can improve the perception that the ICT system is useful. Faculty should perceive that there is little added effort necessary to implement the ICT system. Perception of effort can negatively impact faculty use of ICT systems. Also contributing to the ease of use, faculty using the ICT system should have general technology self-efficacy, or the belief that their own technology skills are satisfactory to use the proposed ICT system. Faculty member age has been shown to negatively impact faculty perception of usefulness and technology self-efficacy. Focusing on perception of usefulness and development of training to improve technology self-efficacy can reduce the impact of faculty member age on technology acceptance. This self-efficacy also improves the perception that the ICT system is easy to use. Faculty age can increase the level of effort expectancy in the use of educational technology in the classroom. Along with the approach of focusing on usefulness, social influence can reduce the impact of age on system use. The creation of a community of users to share best practices and increase faculty-to-faculty collaboration can help to decrease effort expectance and reduce the impact of age on technology use.

To improve faculty acceptance of technology, several implementation strategies should be created. The first strategy is a continuation of the established goals mentioned in the administrative support section. Having clear established goals for the ICT system can improve faculty perception of system usefulness. Goals for this section can be shared with those established in the administrative support section. Goals should focus on specific goals related to faculty adoption. The goals can include improvement in classroom collaboration, student engagement or student learning improvement resulting from ICT system use.

To address faculty perception of ease of use, additional implementation strategies should revolve around faculty training and assessment of technology self-efficacy. Self-efficacy of faculty users should be assessed prior to system implementation. As mentioned in the technology section above, training for the specific technology should be included in the model to counteract the impact of lower technology self-efficacy. Those that have technology-self efficacy still require specific professional development and training in the use of the ICT system.

Measurement of Criteria

To measure the ability for the ICT system implementation to meet the criteria in this category, the following components are necessary:

1. Clearly established goals for ICT system use at both the institution, division and at the classroom level, which may include the following examples:
    a. Student learning and performance improvement
    b. Student and faculty collaboration improvement
    c. Student classroom engagement improvement
2. Creation of assessment measure for faculty technology self-efficacy.
3. Professional development and training for specific ICT system use to increase perceived usefulness and self-efficacy.
4. Creation of a community of faculty users to share best practices.

Student Technology Acceptance

Similarly to the section on faculty, the student technology acceptance category identifies criteria related to several constructs in technology acceptance research. The constructs of perceived usefulness, performance expectancy, perceived ease of use, social influence, student age and self-efficacy were all identified by the expert panel as significant to the development of an implementation model. Students should find the ICT system easy to use and have lower effort expectancy. Students should also perceive that the ICT system is useful in the classroom environment. Students also influence peers in the use of ICT systems. Age was also noted as a factor for resistance to use technology for both categories.

Approaches for Implementation

Performance expectancy, or the perception that the ICT system will perform a value added task, is vital for student technology acceptance. Student usage of technology increases with the perception of usefulness that the ICT system provides. Where the student performance expectancy differs from faculty is in the goals section. Student perception of performance expectancy does not necessarily revolve around administration support, rather on the more immediate impact provided on a specific course or program level. A clear definition of the purpose of ICT system implementation is necessary and should be shared with students. That purpose should identify the direct results they will see from its use.

The technology implemented in the ICT should also be perceived as easy to use. Ease of use is not directly tied with student acceptance and use of technology, but ease of use can improve the perception that the ICT system is useful. Students should perceive that there is little added effort necessary to implement the ICT system. Perception of effort can negatively impact faculty use of ICT systems. Also contributing to the ease of use, students using the ICT system should have general technology self-efficacy, or the belief that their own technology skills are satisfactory to use the proposed ICT system.

Age has been shown to negatively impact perception of usefulness and technology self-efficacy, however with student populations this is less of a factor than with faculty. As in the faculty technology acceptance section, the development of specific goals and training can reduce the impact of student age on perceived usefulness and self-efficacy. Student peer collaboration can also decrease the impact of age on system use. As collaboration is increase with ICT system implementation, the impact of student age on use should decrease.

To improve student acceptance of technology, several implementation strategies should be created. Goals should focus on specific goals related to student adoption. The goals can include improvement in classroom collaboration, student engagement or student learning improvement resulting from ICT system use. To address student perception of ease of use, additional implementation strategies should revolve around faculty training and assessment of technology self-efficacy. Self-efficacy of student users should be assessed prior to system implementation. Students who do not have the self-efficacy should have prior training purely in the technology used as mentioned in the technology selection section above. Those that have technology-self efficacy still require specific professional development and training in the use of the ICT system.

Measurement of Criteria

To measure the ability for the ICT system implementation to meet the criteria in this category, the following components are necessary. Some of these components can be paired with faculty users, while others should have a specific focus for student users.

1. Clearly established goals for ICT system use at both the class or program level, which may include the following examples:
    a. Student learning and performance improvement
    b. Student and faculty collaboration improvement
    c. Student classroom engagement improvement
2. Creation of assessment measure for student technology self-efficacy.
3. Development of training for student ICT system use to increase perceived usefulness and self-efficacy.

Pedagogy Integration

This section identifies specific pedagogical concerns with the integration of ICT systems into the higher education environment. Faculty are finding the benefit of creating ICT systems for use in higher education, but there are often challenges with a lack of focused integration with pedagogy. Deliberate focus needs to be placed on pedagogy integration with the technology system. The faculty also need to have high teaching self-efficacy prior to the implementation of technology within the classroom. Faculty have found value in the creation of learning communities and social technology integration. Collaborative learning is a large component with ICT systems and there must be a perception of collaboration improvement for ICT system implementation. ICT systems can support the use of peer collaboration, faculty to student collaboration, and engagement of students outside the physical classroom.

Approaches for Implementation

ICT system integration in higher education, specifically with newer technologies like mobile devices, is still in its infancy. Pedagogical models that have been carried out in prior research can be used to gain insight and best practices for pedagogical integration. While prior studies have been focused to specific populations or programs, an overall approach for pedagogy integration can be reached by researching common strategies of collaboration improvement, student learning improvement, and technology integration into higher education. ICT systems can substantially improve student peer collaboration. Classroom pedagogy should integrate the inclusion of a collaborative or active learning strategy to take advantage of improved student collaboration. These learning activities should be deliberately integrated into curriculum development and course design. Assessment of classroom goals should be in place to measure improvement with the use of the ICT system.

Teaching self-efficacy, or the perception of one's ability to organize and execute actions in the classroom, must be high for successful ICT system implementation. Faculty with high teaching self-efficacy are generally more open to new ideas and willing to adopt new concepts in their pedagogy. This self-efficacy has been shown to be correlated with ICT system implementation. New ICT system implementations should only be adopted in classrooms with faculty that have high teaching self-efficacy. The training processes above can bring faculty to a higher level of teaching self-efficacy prior to system implementation. An assessment method should be in place to measure faculty teaching self-efficacy prior to ICT system implementation.

Measurement of Criteria

To measure the ability for the ICT system implementation to meet the criteria in this category, the following components are necessary:

1. Creation of learning activities facilitated through ICT system through pedagogical integration. These learning activities can be aligned with pedagogical concepts including Blooms Digital Taxonomy and the SAMR learning model.
2. Creation of assessment measures for classroom goals impacted by ICT system.
3. Creation of assessment measure for faculty teaching self-efficacy.

Conclusion

ICT system integration in higher education has been sporadically applied and narrowly focused to specific applications or educational settings. This implementation model addresses implementation criteria that can be applied to general, widespread higher education environments. This model for ICT implementation into higher education presents five categories of implementation criteria identified by an expert panel. This implementation model addresses each criterion and identifies potential implementation strategies and measures for ICT system integration into higher education classrooms. The aggregation of implementation strategies and measurement strategies for each category results in an overall implementation model for ICT systems in higher education.

Model Appendix A

Criteria List

Criteria	Mean	SD
Technology Selection		
ICT systems implemented must include technology that is both available and accessible for classroom use by students and faculty (Caballe et al., 2010; Thomas, O'Bannon, & Bolton, 2013).	4.67	0.65
Technology hardware and software capabilities that are provided must match the requirements of the ICT (Caballe et al., 2010; Roig-Torres et al., 2012; Echeverria et al., 2011; Motiwalla, 2007; Economides & Nikolaou, 2008; Meurant, 2010)	4.55	0.82
Users should have prior experience or familiarity with the use of the technology in the ICT system (Echeverria et al., 2011; Toto et al., 2008; Piki, 2010)	3.27	0.79
Administration Support		
Faculty training for ICT system use must be available (Thomas, O'Bannon & Bolton, 2013; Toto et al., 2008; Roschelle et al., 2010).	4.92	0.29
Management or Administration of the institution must show support for ICT system use (Huda & Hussin, 2013; Huang et al., 2011).	4.75	0.45
Appropriate measurement of ICT system success must be in place prior to the system being implemented. (Piki, 2010)	4.33	0.78
Faculty should not have perceived student distraction and detraction from the classroom material because of technology use (Caballe et al., 2010; Thomas, O'Bannon & Bolton, 2013; Sharples & Roschelle, 2010)	3.82	0.6
Faculty Technology Acceptance		
Faculty should perceive usefulness of the ICT system (Caballe et al., 2010; Echeverria et al., 2011; Huai, 2008; Huang et al., 2011)	4.18	0.75
Faculty should perceive that the ICT system is easy to use (Huai, 2008; Huang et al., 2011).	3.82	0.87
Lower effort expectancy by faculty will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)	3.64	0.81
Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009)	4.33	0.65
Faculty should have general technology self-efficacy (Ball & Levy, 2009; Huai, 2008; Roschelle et al., 2010).	4.25	0.62
Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)	3.64	1.03
Student Technology Acceptance		

Students should perceive usefulness of the ICT system (Souleles et al., 2014; Munoz-Repiso & Tejedor, 2012; Motiwalla, 2007; Sumak et al., 2010; Anderson et al., 2006; Wang et al., 2009)	4.18	0.75
Students should perceive that the ICT system is easy to use (Zurita et al., 2008; Echeverria et al., 2011; Economides & Nikolaou, 2008)	3.91	0.83
Lower effort expectancy by students will increase success in ICT system implementation (Birch & Irvine, 2009; Wang et al., 2009)	3.82	0.87
Social Influence, either positive or negative, can impact ICT system perception of usefulness (Sumak et al., 2010; Wong & Li, 2008; Huang et al., 2011; Wang et al., 2009)	4.33	0.65
Students should have general technology self-efficacy (Munoz-Repiso & Tejedor, 2012)	4	0.45
Older users will be more resistant than younger users to use the ICT system. (Meyer & Xu, 2009; Wang et al., 2009)	3.64	1.03
Pedagogy Integration		
The ICT system must be deliberately integrated into the pedagogy for the classroom (Caballe et al., 2010; Souleles et al., 2014; Murphy, 2011; Zurita et al., 2008; Alvarez et al., 2011; Chung, Kuo and Liu, 2010; Meurant, 2010; Wong & Li, 2008).	4.58	0.67
Teaching self-efficacy, or faculty perception of the capability execute actions in the classroom, must be high (Sang et al., 2010)	4.18	0.75
Users should have a perception of collaboration improvement with the use of ICT system. (Zurita & Nussbaum, 2007, Zurita et al., 2008; Thomas, O'Bannon, & Bolton, 2013)	3.64	0.67

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Model Appendix B

Sample Requirements Document

Technical Requirements for Home Computer

Students must have a computer with the following hardware and software (additional equipment and software may be required for some courses):

<u>PC Requirements</u>

Intel Core I3 Processor or higher
Windows 7 or higher
4 GB of RAM required
80 GB Hard Drive
Microsoft Office 2010 (Higher version may be required in some classes)
IE 9 and/or a recent / updated release of Firefox or Chrome
Java 7
Virus protection software
Webcam recommended and may be required in some courses.

<u>Mac Requirements</u>

OS X 10.7.3 or later
4 GB of RAM
80 GB Hard drive
Microsoft Office - Mac 2011 (Higher version may be required in some classes)
Safari 6.1.5 and/or a recent / updated release of Firefox or Chrome
Java 7
Virus protection software
Webcam recommended and may be required in some courses.

Technical Requirements for Mobile Devices
(Smartphones are not a recommended mobile device – for most classroom activities)

Battery life should be 6 hours minimum
WiFi capability
Webcam/camera
If submitting assignments from the classroom, must have the ability to convert work to a Microsoft Office output (Google Drive can do this for Word, Excel, PowerPoint).

Model Appendix C

Sample Technology Use Policy

I. Introduction

This policy defines the accountability of all (“Users”) as well as the boundaries of acceptable use of computing and communication recourses. The institution provides robust resources to support the information technology (IT) environment, including computers, data storage, mobile devices, electronic data, networks, software, email services, electronic information sources, voicemail, telephone services, and other products and services. The computing and communication resources are the property of the institution and are used to support the advancement of education, services, community, and administrative business support services. IT resources are provided for the use of faculty, staff, students, and courtesy affiliates. This policy is intended to help protect the institution and its constituents as it relates to privacy and confidentiality as well as the overall integrity of IT resources. Having a sound and effective information technology environment is essential to the Mission. When utilizing resources, you agree to the Acceptable Use Policy language.

II. Applicability

2.1 This Policy applies to all individuals using resources, regardless of affiliation (faculty, staff, students, and courtesy affiliates) or where the resources are accessed or used, i.e. campus or remote locations.

2.2 For usage within the campus IT environment, additional rules may apply to specific resources, including classrooms, business systems, networks, software, social media, databases, and other services and support. Rules will be consistent with this policy and could potentially enact additional requirements and/or responsibilities on the Users.

2.3 Access to resources may be wholly or partially restricted without prior notice and without consent.

2.4 Access to this Policy will be granted to Users through the website, handbook and/or catalog.

III. General Authorized Usage Overview

3.1 Resources are provided for College-specific objectives, including supporting the College’s mission, teaching, administrative actions, and student/student-life activities, including social media usage.

3.2 Users are granted access to IT resources and are responsible for all activity performed with their user IDs. Users should take appropriate precautions to ensure the security of their passwords and prevent others from obtaining access to their computer resources.

3.3 Inappropriate or supplementary use that inaccurately or inappropriately illustrates support or affiliation of products, services, or organizations, without written approval, is prohibited.

3.4 Usage of resources for supplementary personal use is done at the user's own risk. The College cannot and will not guarantee the continued operation, support, or security of IT resources.

3.5 Users are responsible for informing themselves of any policies or regulations that control the use of College resources prior to resource usage.

3.6 Users are expected to respect the privacy of other Users, including usage, content, or identities.

3.7 Users are required to comply with state, federal, and local laws as well as College policies. Additionally, Users are required to adhere to the rules and regulations dictated by third parties.

3.8 Users are expected to engage in safe and responsible security and computing practices in order to maintain the integrity of resources.

IV. Inappropriate Usage

4.1 The use of resources for private business, commercial activities, fund-raising, or advertising for non-educational purposes is prohibited unless approved in advance.

4.2 Users must adhere to copyright, trade secret, patent, or other intellectual property or similar laws/regulations.

4.3 Using college resources for unlawful communications, including threats of violence, obscenity, child pornography, and harassing communication are prohibited and will immediately be reported to the local police department and/or campus safety.

4.4 Unauthorized access, modification, copies, or deletion of Users' accounts or resources, including files, is not allowed.

4.5 Users cannot use IT resources in a manner that impacts usage or activities of the resources by other Users including, but not limited to, the introduction of malicious software or malware.

4.6 Connecting unauthorized modems, routers, wireless access points, or other devices to college resources is prohibited.

4.7 Interfering with the networking including, but not limited to, scanning, monitoring, intercepting, and altering network packets is expressly prohibited.

4.8 College resources cannot be used to engage in patrician politics or promote/oppose ballot measures unless that use is approved by the President/CEO.

4.9 Users cannot access resources without the proper authority, which includes attempting to evade or circumvent user authentication and/or misrepresenting one's identity or affiliation.

V. Email and Electronic Communications

5.1 Access to college email is a privilege that may be wholly or partially restricted without prior notice and without consent of the user.

5.2 An activity that may strain the email or network facilities is a violation of this policy. These activities include, but are not limited to, sending chain letter and widespread dissemination of unsolicited email.

5.3 Modification or forging of email information, including the header, is prohibited.

5.4 Confidentially of email or other electronic communication cannot be assured; therefore, Users should be aware of the risks when sending confidential, personal, financial, or sensitive information.

VI. Social Media

For specific policies, procedures, and code of conduct, please reference the following documents: Student Social Media Code of Conduct and Faculty and Staff Social Media Policies and Procedures.

VII. Privacy

7.1 Privacy is important to the institution; however, Users should be aware that the data created or stored on college resources remains the property of the institution.

7.2 Users are expected to respect the privacy of other Users and not divulge personal data concerning faculty, staff, or students.

7.3 Authorized individuals of the IT environment will perform management tasks in a manner that fosters User trust.

7.4 The College does not routinely monitor individual usage; however, normal operations require the backup of data, logging of activities, monitoring general usage, logging files, and other similar activities. The institution may access various resources in order to perform necessary maintenance, including security events.

VIII. Enforcement

8.1 Use of institution resources is a privilege and not a right. User’s access to IT resources may be limited, suspended, or terminated if that User violates the Policy. The CIO or the Director of Security will address alleged violations of this Policy.

8.2 In addition to review of alleged violation of this Policy, the college may be obligated to report incidents to law enforcement.

8.3 Users who violate this Policy, other college policies, or external laws will be subject to disciplinary action and/or penalties.

8.4 If the CIO determines that a User has violated this Policy and determines that access should be limited or suspended, the User may appeal that decision to the Executive Committee.

Appendix M

Pre-Evaluation Round 2 Instructions

Expert panel:

Thank you for your participation in the pre-evaluation of the implementation model. All but two of the criteria were identified as 'satisfied' by the implementation model having a consensus above 3.0 rating. The two criteria remaining were regarding faculty and student age.

The comments received by expert panel participants are as follows:
1. It has not been my personal experience that age is a predictor of adoption.
2. This is assuming a bit too much in my book.
3. I believe age differences in technology adoption are diminishing.
4. Again, this can vary quite a bit depending on sample

Researcher Feedback:
I appreciate that you may not all agree that age is a predictor, however if you recall the expert panel as a group decided to go by a simple majority on those two criteria in the development phase. Research will tell you that age is indeed a moderator of behavioral intention to use technology. The research also shows that creating clear goals and purposes for system use, as well as the creation of a community of practice for system use can reduce the impact of age on technology use. I have added a few statements on pages 8-9 and 11 to reflect that research.

After reading research feedback, and reviewing pages 8, 9 and 11 of the implementation model, please re-rate the two criteria below. Please rate the implementation model on its ability to satisfy the given criteria.

Scale for Criteria Rating
5. Strongly Agree
4. Moderately Agree
3. Neutral
2. Moderately Disagree
1. Strongly Disagree

You will be asked for a short rationale for any criterion that you rate at less than 3.
Please complete this form by Friday, June 26th. If you are unable to meet that deadline, please let me know as soon as possible.
Thank you,
Tom Kurtz

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