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Antecedents of Adopting e-Learning: Toward a Model of Academic e-Learning Acceptance

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Abstract

This study investigates factors that predict the successful adoption and implementation of e-learning technologies in college level courses. The study employed "availability sample," to collect data via face-to-face interviews with academic professionals in a small liberal arts and sciences college in the Midwest. Two hundred and twelve members of the faculty were targeted, of whom 129 (60%) completed the interviews. Several layers of analysis were performed to test the effects of academic backgrounds and other demographic variables on the perceptions about and the tendencies to adopt e-learning. It was found that the academic background variables did not yield significant correlations with perception about, and the decision to adopt, e-learning. The data showed that the primary interest in the correlates of the decisions to adopt e-learning is the faculty's self confidence in using the technology and online resources.

Keywords: e-learning, information technology, teaching model, faculty perceptions, decision to adopt

1. INTRODUCTION

"E-learning" has been commonplace in many learning environments at all educational levels. There have been many attempts to provide a concise definition of the term (e.g., Guri-Rosenbilt, 2005; Selim Ahmed, 2010), it simply signifies any type of teaching-learning module that involves computer technology and online resources. The tendency toward e-learning necessitated investing in this area, which has been a top-down decisions, as Jones and O'Shea (2004) have suggested. However, the decision to integrate and adopt e-learning in the classroom seems to be predominantly a matter of the individual faculty's choice, and in most instances seems to depend on the technology's ability to shift the faculty-student productivity.

The emphasis on e-learning also has created a great deal of sociological and pedagogical concerns for this new pedagogy's functionality, among which the end users' perceptions of the technology as an effective teaching-learning tool and e-leaning's effectiveness as it stands out by itself (Ahmed, 2009) seem to be paramount. The fear is that technology has a tendency to create an uneven development of the Internet use—namely, the "digital divide" (Guillen & Suarez, 2005; Smith, 2003). Has this been the case, then the conditions that foster adopting e-learning in classrooms are significant factors that may be conducive to the end users' characteristics. Hence, this study investigates the challenges of adopting e-learning in relations to the end users' characteristics, and the antecedents that affect the decision to integrate or adopt e-learning in teaching.

A common myth about the reluctance to incorporate technology in classrooms is "the air of mystery" that surrounds computers. In reality, the mystery stems from the "fear of the unknown;" computers were known as a device used by intelligent people. Viewing the issue from this angle, the origin of this fear lies seemingly in one's awareness of one's inability to use technology. Therefore, confidence in one's ability and knowledge of e-learning technologies become critical factors in deciding to adopt e-learning. Because technical skills are parts of the professional development nowadays, it remains to be seen if engaging with the task is a matter of making a connection between self-efficacy and perceived abilities in engaging with the task. This demands a shift from pedagogy to androgogy: a shift of paradigm from "the sage on the stage" information generator to "the guide on the side" coach (Wang, 2002). Thus, adopting e-learning require a new look at the challenges of the delivery system and whether the currently in-placed methods need to be revamped.

2. LITERATURE REVIEW

Although research on e-learning is diverse, it can be classified into three broad, but distinct categories. The first category includes research focused on the development of pedagogical e-learning modules and designs (e.g., Behar, 2011). This genre looked at the effectiveness of a "purely online" teaching-learning model, as compared with the traditional classroom format or the "hybrid" modules. The second category covers evaluating the learners' satisfaction and experiences with e-learning (e.g., Saade, He, & Kira, 2007). The third type, which is also a focus on perceptions, entails research that investigated the stakeholders (i.e., the upper managers and/or the Board) and their willingness to invest in this technology (e.g., Brown, 2003; Rogers, 2003).

Research on "perceptions" predominantly investigated the students, staff, or the stakeholders. The preponderance of research in this category is conducted overseas (e.g., Agbatogum, 2001; Liaw, Huang, & Chen, 2006; Panda & Mishra, 2007)—especially in developing countries where there is a great deal of hope and expectations, but uncertainty about including technology in teaching and learning (Behar, 2011; Newton, 2003; Haywood, Anderson, Doyle, Day, Haywood, & McLeod, 2000).

Research on the stakeholders' perception scrutinizes the upper management's perceptions, or the Board's interests in investing in e-learning technologies (Marouf & Rehman, 2007). Whether the concerns are either investing in technology or in learning, the pedagogical designers keep an eye on the learner and the accentuated user-friendly aspects of e-learning technologies. Investment efforts focus heavily on the consumers' (students') needs and interests (Norman, 2002), but ignore the faculty. This is evident in the literature, which is silent on the pragmatic and pedagogical concerns of the "educator" about e-learning.

The literature is also silent on whether e-learning is a high priority for the faculty. The popularity of research on the students' needs, and the stakeholders, has undermined research on the faculty perceptions and their decision to adopt e-learning. The focused on the students reflects predominantly a sample of courses that required laboratory experiences and one-on-one instructions (e.g., Yazon et al., 2002). Drawing viable and applicable inferences from such research to the Liberal Arts disciplines and Humanities is suspect because of the varying approaches in the latter disciplines. On the other hand, a few who studied the faculty and their decision to adopt technology focused on the situational variables such as the appeal to adopt e-learning (Liu, Hodgson, & Lord, 2010).

It is commonsense to assume that the teaching environment dictates the development of a customized pedagogical model. A seasoned faculty teaches differently in different teaching environments. The success and workability of an e-learning environment, therefore, depends partially on the momentum created by the faculty in terms of their perceived capabilities, preferences, and productivity. Kuo and Ye (2010) provided evidence to verify that the decision to adopt e-learning is attributable to structural factors such as, length of work experiences and levels of authority. Their research, however, did not specify whether the faculty's rationale to adopt e-learning rests on: 1) its usefulness in performing the required tasks, 2) its ability to crystallize the achievement of the intended pedagogical goals and being productive, or 3) simply because it is a fad.

Although not the intent of the current study, but research on the effectiveness of e-learning also has yielded contradictory findings. For example, MacKeog and Fox (2009) found an ambivalent correlation between e-learning modules and their effectiveness in learning and knowledge generation, while Wong's and Huang's (2011) review of several empirical studies supported the positive and effective outcomes of e-learning. Selim Ahmed's (2009) research puts an interesting spin in the notion of e-learning by revealing a series of potential drawbacks in pure e-learning. He contended that e-learning is more effective in hybrid learning environments. Citing other studies (such as Yazon, Mayer-Smith, & Redfield, 2002), Selim Ahmad (2009) saw the root cause of the failure of pure e-learning in the lack of face-to-face contact with the instructor and classmates.

The contradictory findings in research on e-learning are not isolated. For example, Dillenbourgh (2002) and Brewer and Klein (2006) reached similar conclusions. They have recommended the need for maintaining contact with fellow students regardless of the employed learning model. Although these recommendations are advocating the need for a mentor or a monitor even in a pure e-learning environment, research findings in this area do not specify whether the contact person should be the faculty, a peer mentor, tutor, or a teaching assistant. Thus, these recommendations surmise that it is very unlikely for e-learning to completely replace face-to-face classroom teaching-learning models (Oh, 2003).

Therefore, the faculty decision to adopt e-learning can be affected by set of factors ranging from their acceptance of technology to their skill level. The skill level is often viewed in terms of "technical skills". For example, a number of researchers (e.g., Haywood et al., 2000; Newton, 2003; Roca, Church, & Martinez, 2006; Tsai, 2011) have suggested that learning how to integrate heterogeneous e-learning systems is also a measure of the faculty's skill in creating and training an effective pedagogy. There may be pressure from the administrators to adopt, as MacKeog and Fox (2009) have argued, but as the literature suggests, adopting e-learning rests on the adopter's comfort level with his or her perceived abilities—the prediction that he or she has learned enough to be comfortable with that stage of technology. Arguably, the pressure from the top may hinder the motivation to adopt e-learning, as Engelbrecht, (2005) observed, if the basic faculty behavior and characteristics (i.e., skills, preparedness, perceptions, willingness and preference to employ e-learning) are absent. As the literature suggests, these and the appropriateness of technology are important human capitals that determine the success of the decision to adopt.

3. THEORETICAL FRAMEWORK

The above review delineates several key, but separate, specificities that dominates research on e-learning. E-learning does not seem to be specific to either industry or academy, despite the differences in their conceptual definitions and approaches. It would appear that the academic environment in higher education is swayed toward adopting the business model in education. Both environments have adopted the technology with similar intentions: e-learning is the magic wand in teaching and learning. Thus, they share in common a question: What factors predict a successful adoption of e-learning technologies in the production of knowledge? Another related question is: Which characteristics play elemental roles in predicting the tendencies to adopt the technology, which in turn are assumed to enhance effective teaching-learning?

Although the literature provides inconclusive answers to these questions, one may contend that the common denominators in adopting e-learning to be motivation, attention, and emotions regarding e-learning. Although these are important psychological factors in decision-making, borrowing from Peterson (1995), this study address these question by investigating the end users, their characteristics (e.g., Intellectual capabilities, knowledge, and perceptions), and the technical issues that determine the decision process. Included in this theoretical model is also the faculty's willingness to adopt, and their competence, which are two other key factors in adopting e-learning in teaching.

The proposed theoretical model assumes that the decision to adopt e-learning depends on the end user's perception that such technologies can be useful (i.e., "efficient," "effective," and "productive") teaching-learning tools. In other words, instructors are effective in an e-learning environment if the technology can be used as a facilitating tool. Thus, the source for deciding to adopt e-learning is a social psychological one that reflects the user's perceived functionality and efficacy of this module; both of which can be translated into factors such as usefulness of e-learning in preparing for a class and the delivery methods.

In summation, the proposed theoretical model in this study attributes the success of e-learning to other structural variables such as self-awareness (i.e., knowledge of the technology, skills, and the comfort level with one's ability to navigate the system), and the end user's socio-cognitive state (i.e., perceived functionality and usefulness of e-learning as effective delivery tools). Thus, the pedagogical effectiveness of e-learning is a function of its perceived usefulness, the end user's academic credentials and professional experiences. Here, e-learning is treated as the framework (tool), not the content; its extent is limited only to its relevance to, and implications for, educational training and development. Figure 1 (Appendix A) summarizes the theoretical model and its conceptual framework in this study. This model assumes a standard format (using z-score coefficient) where X_1= Academic Background, X_2 = Confidence, X_3= Perceptions about e-learning, and X_4= Decision to Adopt e-learning. Hence the structural equation for the working model is:

$$\boldsymbol{X_4 = P_{41}X_1 + P_{42}X_2 + X_{43}} + \sum_{J=1}^{3} \epsilon$$

Where *P* presents the direct causal effect coefficient (i.e., path coefficient), and ϵ reflects the *error* terms or the residual effects of the combination of any other factors not predicted in the model.

4. METHODS

Race and gender occupy a preeminent place in research on the digital divide. However, the attention to the work experiences and levels of authority has been constrained to the (business) organizational environment. A focus on the demographic factors in studying the decision to adopt e-learning in the academic environment must merit similar consideration. These latter factors can be measured in terms of tenure situation, academic ranks, or levels of authority and seniority.

Variables and Measures

Four different additive scales were created to measure factors studied in this research. These scales measured: 1) the end users' (i.e., the faculty) academic backgrounds; 2) their perceptions of the usefulness of e-learning technologies; 3) their confidence in their abilities (or competence) in using e-learning technologies and resources; and, 4) the faculty tendency to adopt e-learning technologies and resources. Four items (i.e., educational degrees, years of service, academic rank, and tenure status) measured "academic backgrounds". Another set of three items quantified the faculty "perceptions" about technology. Three items generated data on one's confidence in his/her technological "skills and competence". Two items assessed the tendency to "adopt and implement" technology-based resources in classrooms.

Content validity was assessed by piloting the questionnaire at a regional professional conference, and by modifying the questions several times. The first layers of analysis included an examination of the reliabilities of the "academic background," "perception," "confidence," and "adoption" scales. Chronbach's α ensured internal consistency and reliability. Chronbach's α for academic background was .75; it was .70 for perception and confidence, respectively. The value of α for the tendency to adopt technology in classrooms was .64 (the recommended α is .70 or greater). Also, other demographic variables (such as age and sex) acted as control variables; they helped detect the differences between categories, and their effects on the decision to adopt e-learning.

Limitations

The low α value for the measures of "adopting technology" is a cause for concern. One concern with reliability was whether the diversity in the training culture among the faculty was a deterrent factor in the construction of this scale. Another concern was whether the respondents' teaching background and their years of service had affected reliability. However, after conducting a split-half analysis, the F ration between the two groups in each item of this scale was statistically significant ($p < .000$).

Sample and Data

The theoretical population in this study is the faculty teaching in liberal arts colleges and university. This study targeted all members of the faculty in a small (close to 250 faculty and 6,500 student body) Liberal Arts college in the Midwest. The actual population represents a wide variety of academic background, ranks, sex, and work experiences. Out of 212 names contacted, 129 (60%) completed the surveys. The sample included 56.6% males; a majority of 73.2 % completed their doctoral degree; and, the average years of teaching experiences was 15 years. Although only 30% surveyed were tenured, 52.8% were on tenure track, and the rest had other types of employment statuses. The sample included diverse representation of the academic ranks: only 18.9% surveyed were instructors or had other similar ranks, 33.9% were assistant professors, 19.7% were associate professors, and 27.6 percent were full professors. The question regarding the age of the participants asked the actual age. With a mean of 40-49 years of age, this faculty body is fairly young.

5. ANALYSIS AND FINDINGS

The second layer of analysis investigated the bivariate relationships between the variables in the hypothetical model (see Appendix B, Table

1). The Spearman Rho was used because of the ordinal nature of the variables and the scales examined in this study. The tests of the relationships between the variables of academic background scale (i.e., years of service, academic rank, tenure status, and academic degree) revealed no significant correlations with the endogenous variables (i.e., confidence, perceptions, and the tendency to adopt e-learning) in this study.

The preliminary findings suggest that facets of academic backgrounds are not significantly correlated with a faculty's perceptions on the usefulness of e-learning technologies (data not shown). However, the degree of confidence in one's knowledge of how to implement e-learning technologies is closely associated with one's tenure status and academic degree. Further analyses indicate that neither years of teaching experiences nor the academic rank significantly correlated with one's confidence in being able to incorporate e-learning in classroom teaching. Implementing e-technologies in classrooms, however, showed a statistically significant correlation with the faculty's academic rank: junior faculty members (at the rank of assistant professor and below) were more inclined toward adopting e-learning technologies in classrooms. In sum, all variables of academic backgrounds, except for rank, did not produce any statistically significant correlation with adopting e-learning. Likewise, the additive "academic background" scale did not show any statistically significant correlations with perception, confidence, and adoption. It remains to be seen whether there is a difference in tendency to adopt e-learning between computer science and engineering faculty and other instructors. Future research can be more attentive to this question.

The next layer of analysis focused on the bivariate relationships among the variables in the hypothesized model (see Appendix C, Figure 2). The data in Figure 2 shows strong and statistically significant correlations among different possible pairs of variables in the model—i.e., perception and confidence ($r = .23$, $p = .01$); and, confidence and adopting ($r = 31$, $p = .001$). The slight exception in this model is the correlation between "perception" and "adopting e-learning" scales, which did not show a statistically significant correlation ($r = .14$, $p =.05$).

Although the empirical data shown in Figure 2 is consistent with the hypothesized path model, except for the effects of the academic background variables, a path analysis was conducted to ensure proper fit, and to ascertain the possible causal relationships among the antecedents of adopting e-learning. This layer of analysis included testing several possible regression equations that ensured proper mapping of the missing and additional links in the model; it also tested the correspondence between the hypothesized model and the empirical data. Figure 3 (Appendix D) portrays the revised model according to the empirical data. The revised model specification is more complicated than the linear structural equation for the hypothetical model. The assumptions for testing this model are: 1) the residual terms are not associated with the independent variables; 2) the variables are measured without errors as verified by the Chronbach's reliability test; and, 3) the relationship between the independent and dependent variables is linear (Mertler & Vannatta, 2002).

The significant standard regression coefficients (Table 2; and, in Figure 3) demonstrate that the results of the bivariate analysis—i.e., no significant effect by academic backgrounds—to be consistent with the original model. The standard regression correlations for the revised model also seem consistent with the initial bivariate correlation, except for the effects that "perception" has on adopting e-learning ($\beta = .07$). According to the data in Figure 3, the primary interest in the correlates of the decisions to adopt e-learning is the faculty's self confidence in knowing how to use the technology ($\beta = .21$). This is also consistent with the original model.

Table 2. Standard Regression Coefficients

Variables	1	2	3	4
1. Academics	#			
2. Confidence	.12	#		
3. Perception	-.09	.20*	#	
4. Adopting	.09	.21**	.07	#

** Correlation is significant at $p < 0.001$ level (2-tailed)
* Correlation is significant at $p \leq 0.05$ level (2-tailed)

Since the original model did not fit the empirical data, we can assume that some degree of variance in adopting e-learning and its effectiveness may be due to the unexplained portion of the exogenous variables (i.e., academic background, confidence, and perceptions about e-learning. As a result, another layer of analysis obtained the reproduced correlations based on path decomposition (or tracing) of all possible combinations of causal relationships among the variables (Table 3). The path analysis determined stronger correlations in three pairs of the correlates of adopting e-learning (i.e., confidence and adopting, confidence and perception, and perception and adopting) in the revised model.

Table 3. Reproduced Correlations For the Revised Model

Variables	1	2	3	4
1. Academics	#			
2. Confidence	.12	#		
3. Perception	-.01	.24	#	
4. Adopting	.12	.34	.14	#

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

Research on e-learning is helpful in understanding its effectiveness or usefulness as compared with the traditional lecture courses. While it is impossible to present a unified e-learning theory, we can pinpoint some of the factors that positively affect this type of learning environment. As the literature suggests, e-learning received many positive marks in business organizational settings (e.g., Wong and Huang, 2011). However, the verification that an academic environment can replicate a business organizational teaching-learning model is highly disputed in the literature.

The theoretical focus on recognizing the faculty's functionality, experiences and skills, their confidence in knowing how to implement e-learning technologies, their perception of the usefulness of e-learning technologies as effective teaching/learning tools, and teaching/learning outcomes yielded inconclusive results in this study. However, the findings suggest that the academic staff's confidence in their ability to incorporate e-learning is a key factor in utilizing the technology and therefore effectively reaching the desired pedagogical outcomes. However, it can be extrapolated from the findings that the faculty's acceptance of the usefulness of such technologies is not a deciding factor for adopting e-learning. As MacKeog and Fox (2009) have argued, it is conceivable that the faculty has grown used to the traditional academic freedom that encourages them to be selective in their teaching practices.

Managing teaching requires the educators to recognize the advantages and disadvantages of one method over another. In the past, the pedagogical functionality and the faculty-student connectivity were more likely to be confined to the classroom periods and/or to the office hours. But, the stakeholders in higher education now believe that functionality and productivity means to help the faculty to "easily access their most critical university-related messages anytime, anywhere" (Huddlestone, 2011, p. 54). Viewed from this angle, the stakeholders expect that e-learning technologies should streamline the work process by increasing the potential for availability and accessibility. The administrators' confidence in e-learning technologies as effective and productive teaching tools may be high (Laurilard, 2006), but Hephaestus is a limping god whose 21st century technological offspring is resisted by many who favor of the traditional classroom teaching behavior. Future research is needed to verify whether the faculty shares this view from the top.

A negative view on adopting e-learning or the end user's confidence may be impediments in a learning environment because such an exclusive focus deters attention from other exogenous factors such as the available technical support systems and incentives (e.g., stipends, teaching load reduction, etc.). This raises a pivotal trepidation in teaching when e-learning's usefulness is questioned. Thus, finding ways of magnifying the usefulness of e-learning and how to create an appeal to that segment of the educators who resist e-learning consume much energy. Among these, as some researchers (e.g., Anderson, Vornhagen, & Campbell, 1998; Jones and O'Shea, 2004) have suggested, is to create the preference to adopt e-learning by communicating its appeal to the faculty in terms of its "usefulness" in delivering and managing information and other teaching related items. This type of endeavor has aimed at increasing e-learning popularity in colleges and universities, but it is not clear whether they have successfully affected the faculty perceptions.

Although the factors mentioned in this section were not included in the hypothesized model of this study, further analysis of the effects of the available technical supports and their efficiency rendered no significant effect on the decision to adopt e-learning. The impact of the incentives on increasing a favorable view of e-learning was envisioned after the data was collected for this study. Perhaps, future studies should focus on improving the model by focusing on impacts of the available incentives on the use of e-learning and its growth on a college campus.

In conclusion, the incessant growth in information technology and the demand for professional development in education necessitated positioning academic professionals with new knowledge, skills, and personal attributes comparable to those desired in the business world. The need for supporting and incorporating e-learning in pedagogy stems from the assumption that it is a form of investment to stay in the race (Anderson, Brown, Fiona, Sampson, & Mentis, 2006; Blake, 2009). However, this is an investment that is looked upon suspiciously for its inconclusive outcomes.

7. ENDNOTES

1. The U.S. Senate and the former President Bill Clinton agreed on approving national Digital Empowerment Act that focused on funding for school technology (U.S. Senate, 2000). But, the situation is uncertain around the globe. For example, most of the concerns in scholarly circles seem to have been redirected towards how the population in developing countries are fairing in the Internet haves-and-have nots matrix. This is not to disregard the importance of race (Atwell, 2001) and gender (Volman and Van Eck, 2001) in maintaining the status quo in education despite the increased computer and Internet usage both in schools and at homes.

2. For example, see Rizza's (2008) study of pre-service teachers.

3. These factors relate to what Ritzer (2004) might have labeled them as "the McDonaldization of education".

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APPENDIX A

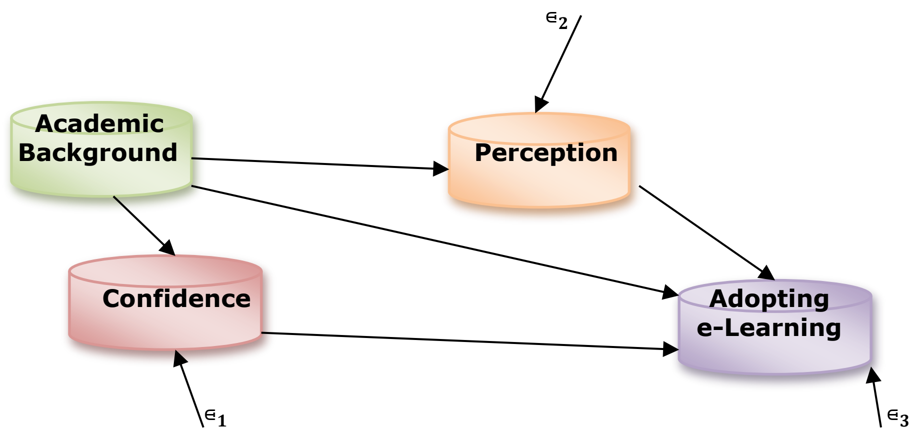

Figure 1: The Hypothetical Model

APPENDIX B

Table 1. Descriptive Statistics and Bivariate Correlation Values

Variables	**Mean**	**SD**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
1. Academics	2.16	1.06	#						
2. Confidence	2.18	1.21	.12	#					
3. Perception	2.12	0.93	-.01	.23*	#				
4. Adopting	1.88	.86	.09	.31**	.14*	#			
5. Effectiveness	2.69	1.17	.03	.18*	.41**	.21*	#		
6. Gender	1.42	0.49	.05	.28**	-.01	-.05	-.04	#	
7. Age	3.30	1.03	-.45**	.18*	-.02	-.01	-.05	.03	#

** Correlation is significant at $p < 0.001$ level (2-tailed)
* Correlation is significant at $p \leq 0.05$ level (2-tailed)

APPENDIX C

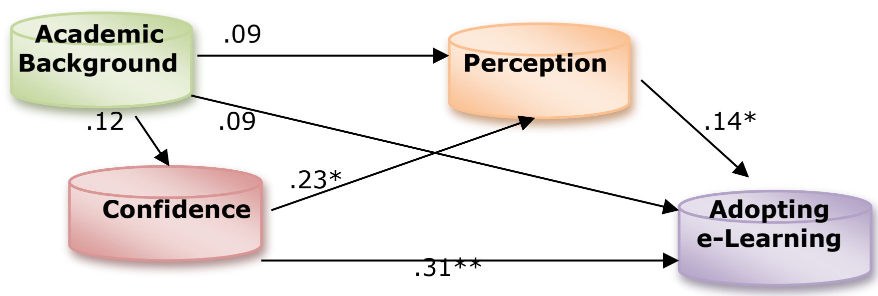

Figure 2. **Path Model with Bivariate Statistics (Spearman Rho)**

** Correlation is significant at $p < 0.001$ level (2-tailed)
* Correlation is significant at $p \leq 0.05$ level (2-tailed)

APPENDIX D

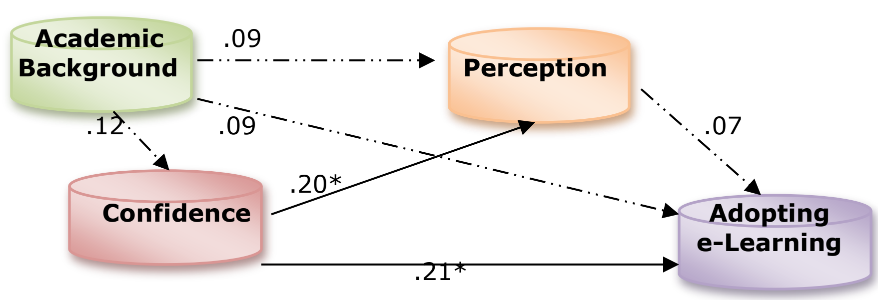

Figure 3. **Modified Path Model with Standard Regression Coefficients**

** Correlation is significant at $p < 0.001$ level (2-tailed)
* Correlation is significant at $p \leq 0.05$ level (2-tailed)

Cloud Computing in Support of Applied Learning: A Baseline Study of Infrastructure Design at Southern Polytechnic State University

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Abstract

Cloud computing represents an architecture and paradigm of computing designed to deliver infrastructure, platforms, and software as constructible computing resources on demand to networked users. As campuses are challenged to better accommodate academic needs for applications and computing environments, cloud computing can provide an accommodating solution for mobile, campus laboratory, and distance computing. The need for ubiquitous software deployments, virtual environments, software acceleration, economies of scale, and on-demand services points to cloud computing solutions for expedient network access to a pool of shared resources. In this baseline study, as part of a nascent research track, the researchers examine a proposed design for cloud computing at Southern Polytechnic State University to support action research, applied learning and practical, real-world student experiences at the university. Access to university cloud computing resources via an academic research network, physically isolated from the current production network, is proposed. Following a system development life-cycle methodology, design criteria are derived from an analysis of focus group data involving questions related to academic research, applied instruction, and experiential and service learning. Presentation of findings occurs in the form of a use case and architectural topology rendering to be used as a basis for follow-on study in this research track. Physical implementation of cloud computing models at the University can follow this roadmap as the research track unfolds and data are collected to analyze and evaluate for optimal cloud architecture in support of research and education.

Keywords: cloud computing, virtualization, infrastructure, platforms, software delivery, applied learning

1. INTRODUCTION

According to the National Institute of Standards and Technology (2009), the term cloud computing refers to "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction." Higher education institutions today are considering and deploying cloud computing models to lower the cost of technology implementations, increase access to technology infrastructure, platforms, and software, and develop an environment in which experiential learning, experimentation, and discovery can occur (Ercan, 2010). Using Internet technologies, server clustering, block storage, and virtualization software, institutions can construct private clouds that transparently interconnect end-users with applications, platforms, content, data, and other users in support of research and education goals (Erickson et al., 2009; Nicholson, 2009; Thomas, 2009).

Cloud Computing Development Models

Four cloud computing development models are generally acknowledged: (i) public cloud, (ii) private cloud, (iii) community cloud, and (iv) hybrid cloud. According to Bozelli (2009) and Zhang et al. (2010), public cloud computing can result in security risks not associated with private cloud computing. Public clouds involve a public service provider who offers free or pay-per-service fee structures. Using the Internet for connectivity, public cloud providers operate and maintain the infrastructure. Private clouds normally involve hosting by a single provider to deliver one or more service models to the organization (Youseff, Butrico & Da Silva, 2008). Community cloud models involve shared infrastructure between communities with similar interests (e.g., information security) such that cost sharing is possible (Wyld, 2009). Hybrid clouds can be hosted by a combination of public, private, and community cloud models where end-users can enjoy the benefits of all three (Rayport & Heyward, 2009).

2. FOUNDATION AND PROBLEM STATEMENT

Southern Polytechnic State University currently operates one production network with access to existing cloud computing resources. As a result, testing and experimentation, instruction, and prototype development of information technologies and systems are difficult. The University requires clear separation of development, test, and production environments from which to operate stable administrative and academic application environments, yet accommodates the instructional, research, and development needs of faculty and students involved in computing and information sciences.

Access to cloud resources is currently limited to a single production network, thus creating the problem under investigation in this study: What network topology best facilitates use of a cloud-computing paradigm in support of research and education? Cloud resources exist and reside in the University central data center, School of Computer and Software Engineering data center, and in the planned School of Architecture and Construction Management computing center. Students and faculty in each aforementioned area require distinct technological environments to accommodate mobile computing, experiential learning, action research, and applied instruction. What we want to know is how best to support these requirements using an academic research network model.

3. LITERATURE REVIEW

The term cloud computing represents a continuation of past computing paradigms and has evolved progressively over the past 19 years since the term was introduced by Ramnath Chellappa, Associate Professor of Management Information Systems at Emory University. In 1997, building on seminal concepts of computation as a “public service” or “public utility” put forth by John McCarthy, Chellappa joined an existing telecommunications industry term (cloud) used to describe large Asynchronous Transfer Mode (ATM) networks with the notion of ubiquitous computing. Thus, the term is used to describe older concepts in new ways (i.e., the new normal).

Moreover, technology thought-leaders (e.g., Vest, 2006), note the emergence of a meta-university concept that works in concert with a cloud computing paradigm. The meta-university, as defined by Vest (2006), describes the future concept of higher education as a transcendent, accessible, empowering, dynamic, communally constructed framework of open materials and platforms on which much of higher education worldwide can be constructed or enhanced. Cloud computing works in concert with the sharing of knowledge and resources, a millennium- refined value of academia.

As a computing model, cloud computing follows traditional topological norms such as mainframe, client-server, distributed, multi-processing, n-tier, and grid computing, yet yields potential to support next generation computing paradigms (Delic & Riley, 2009). According to Khmelevsky and Voytenko (2010), cloud computing represents the most significant advancement in information technology since the elevation of the global Internet network. Following mainframe computing, personal computing, client-server computing, and the World Wide Web, cloud computing is considered by many to be the fifth major paradigm shift in computing. Academic institutions continue to embrace the paradigm as a means of: (a) improving return-on-investment for technology infrastructure, (b) improving resource sharing, (c) enabling interactivity, collaboration and innovation among stakeholders of Web content and resources, (d) supporting mobile computing and e-learning, and (e) delivering virtual environments (Sultan, 2010).

Based on Pocatilu, Alecu, Vetrici (2010), cloud computing architecture involves three service model abstractions: (a) infrastructure as a service (IaaS), (b) platform as a Service (PaaS), and (c) Software as a Service (SaaS). IaaS layers servers, storage, and network infrastructure into a pool of computing, storage, and connectivity capabilities that are delivered via the network as services that provide a flexible, standard, and virtualized operating environment. IaaS can be used to establish a foundation for PaaS and SaaS (Banerjee, 2009).

Normally, IaaS provides a standardized virtual machine hosted on a server cluster (Noor, Mustafa, Chowdhury, Hossain, and Jaigirdar, 2010). IaaS consumers have responsibility for configuration and operations of the Operating System (OS), software, and Database (DB). Network delivered services (such as performance, bandwidth, and storage access) also can be maintained via service management strategies that cover the performance and availability of the virtualized infrastructure (Mell & Grance, 2009).

PaaS provides executable environments such as application runtimes, storage, and application integration. Moreover, PaaS provides an efficient and agile method to instantiate scale-out applications in a predictable and cost-efficient manner. Tout, Sverdlik, and Lawver (2009) note that information technology service levels and operational risks are mutual as a result of the consumer taking responsibility for the stability, architectural compliance, and overall operations of the application while the provider delivers the platform capability.

SaaS provides business processes and applications (e.g., e-mail, groupware, and/or collaboration tools) as services where the provider assumes all operational risks. Significant delivery and cost efficiencies are possible as all infrastructure and information technologies are abstracted away from the consumer (Mircea & Andreescu, 2011).

Cloud infrastructure is typically supported by block storage in the form of direct attached storage (DAS), network attached storage (NAS), or a storage area network (SAN). Additionally, server clusters to support virtual machines (VMs), and in some cases high-end computing devices, are all considered part of cloud infrastructure (Sasikala & Prema, 2010). Centers hosting cloud infrastructure (e.g., computing centers or data centers) can have managed host capability as a provider option. Secure and available network and internetworking components provide access to the cloud (Brunette & Mogull, 2009; Mell & Grance, 2009). Internetworking architecture can support cloud *partners* such as affiliated computing and data centers (Armbrust et al., 2009; Khmelevsky, Govorov, & Burge, 2009).

Use of cloud computing within higher education is proliferating, as noted by Pocatilu, Alecu, and Vetrici (2010); Khmelevsky and Voytenko (2010); Noor et al. (2010); and Mircea and Andreescu (2011). Prototype initiatives, such as seen at Okanagan College and the University of British Columbia Okanagan, King's University College, University of California, Washington State University's School of Electrical Engineering and Computer Science, and North Carolina State University, reflect academic use and success with cloud computing paradigms. According to Bozzelli (2009) and Mircea and Andreescu (2011), over the last few years higher education institutions have begun to transition to more research and ongoing update of information technology infrastructure as a foundation for education activities and science research.

Moreover, academic institutions are finding compatibility between cloud computing and other major academic initiatives. For example, Thomas (2009) notes the use of cloud computing in support of the Scholarship of Teaching and Learning (SoTL); Pocatilu, Alecu, and Vetrici (2010) report on cloud computing in support of e-learning; Khmelevsky and Voytenko (2010) research how cloud computing is used in experiential and project-based learning; and Mircea and Andreescu (2011) couple cloud computing with strategies to reduce the cost of education.

Cloud architecture also is associated with higher education institution challenges. According to Goldestein (2009) and McCrea (2009), challenges include technology limitations, interoperability issues, network capacity, end-user perceptions, and adoption of cloud computing concepts. Additionally, policy and control issues, demand for services, and legacy constraints represent challenges when moving to a cloud computing paradigm (Katz, Goldstein, & Yanosky, 2012). Of similar concern, Mircea and Andreescu (2011) note that migration to cloud computing requires a well-defined strategy. Sheelvant (2009) agrees and suggests that successful cloud computing initiatives are dependent on alignment of cloud computing capabilities with higher education research and education needs, as well as clearly stating the architectural vision for infrastructure, platform, and software service delivery (Golden, 2010).

4. RESEARCH METHODOLOGY

In this preliminary study, the researchers used a qualitative approach to collect data. Two focus groups involving University stakeholders with interest in academic cloud computing, primarily faculty, were organized and conducted to elicit responses in five domains: curriculum and instruction, scholarship, research, virtual environments, and access. Focus group A included six faculty members and one technical support personnel, and focus group B included eight faculty members and one administrative personnel.

During each focus group session, participants were asked to respond to ten questions, organized into domains, related to the use of cloud computing features and attributes associated with the domains. The curriculum and instruction domain questions (1-2) concentrated on models of instruction using technology and use of digitized content. The scholarship domain and research domain questions (3-7) were designed to determine how faculty could use cloud computing constructs for experimentation, testing, development, applied instruction, personal learning, and the Scholarship of Teaching and Learning (SoTL). The final two domains assessed, virtual environments and access, focused on questions (8-10) related to use of virtual desktop integration (VDI), mobile network access to cloud components, bring-your-own-device (BYOD) design, and interdisciplinary approaches to the study of information technology and systems using cloud computing resources.

Focus group comments were captured and organized by domain for coding and analysis. Stakeholder input, in the form of focus group qualitative comments and responses to specific questions, resulted in the data set used to reach findings with respect to this preliminary study question. In response to the qualitative data analysis, the researchers constructed a use case (Figure 1) to illustrate the interaction of stakeholders with the abstractions of cloud computing infrastructure. Moreover, analysis of the qualitative data was used to formalize the proposed cloud architecture (Figure 2) accessible via a discrete academic research network (ARN), including a strategy for service management and governance.

5. QUALITATIVE DATA ANALYSIS

Focus Group Data

Focus group data were recorded in narrative form without personally identifying the respondent. The treatment of the data in this research is that of anonymous data. Following the numeric sequence of questions organized by domain, qualitative data in the form of verbal responses were captured without guidance other than the questions presented in written form. Each question was presented and exhaustively addressed by the focus group before moving to the subsequent question. Data analysis involved a coding scheme to determine existence of themes, patterns, and behaviors in the qualitative data. Moreover, an examination of the collected data narratives was examined via a tag cloud engine for comparative analysis with the coding scheme results.

Regarding curriculum and instruction, the data suggest that faculty are interested in and require technology to enable multiple paradigms of course delivery, including hybrid, Web-enhanced, Web simulcast, online, and convergent instruction. Additionally, the data suggest that faculty currently create and use digital content, and view a robust digital learning object repository to accommodate all four quadrants of file types as a necessary element of instruction.

In the domains of scholarship and research, the data suggest the technology services to accommodate advanced content delivery, personal learning, and experimentation, testing, and development as an adjunct to instruction are required and not currently available. Moderate interest in the use of technologies to support SoTL (Thomas, 2009) existed, and awareness creation and adoption of the concept were of value going forward.

Finally, data collected regarding virtual environments and access indicated a high level of interest and need to virtualize desktops, better enable mobile computing, and work collaboratively across the University to enable and enhance the study of information technology and systems. Virtual access and mobile access were dominant, recurring themes in the data. Specific accommodation for technology to support shared storage, virtual machine server clusters, control over Web access, and network management all emerged as major themes and patterns in the data analysis.

Cloud Technology Consumers

Information technology and system stakeholders at the University include students, administrative staff, developers, and faculty lecturers and researchers. Figure 1 illustrates the interactions between University stakeholders and cloud service model abstractions. Based on the qualitative data collected, a use case for University stakeholders and private cloud services illustrates the following: (i) students benefit from SaaS and IaaS, (ii) faculty lecturers benefit from Saas and Iaas, (iii) administrative staff benefit from SaaS and Iaas, (iv) faculty researchers benefit from IaaS and PaaS, and developers benefit from PaaS.

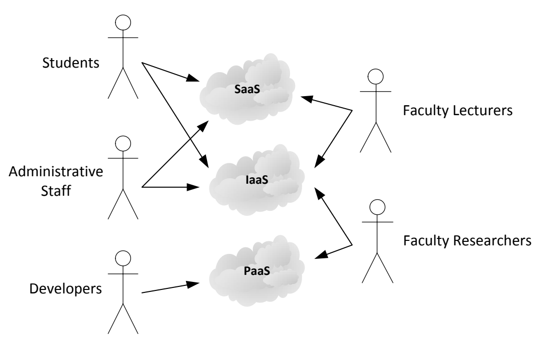

Figure 1: Use Case for Cloud Computing at Southern Polytechnic State University

Service delivery via an academic research network (ARN) requires separate infrastructure and construction of lighted pathways outside of the University's production network, including Internet. The academic value of the network connecting to a private cloud is realized in the ability to develop, test, demonstrate, and experiment. The use case can serve as a model for access and authentication to cloud resources.

6. PROPOSED ARCHITECTURE

Cloud Architecture

The development model (Figure 2) for the proposed architecture is that of a four-tier private cloud, hosted and managed by internal University resources. Access to the cloud resources via an ARN portal allows for secure authentication to cloud resources. Using an authenticated portal for enterprise application integration, cloud services will be available to consumers of SaaS, IaaS, and PaaS. Tier one provides for authenticated access, navigation, application integration, information, and self-service. Tier two, the application tier (i.e., SaaS), provides for utilities, tools, and applications to support collaboration, service management, projects, virtualization, and user administration.

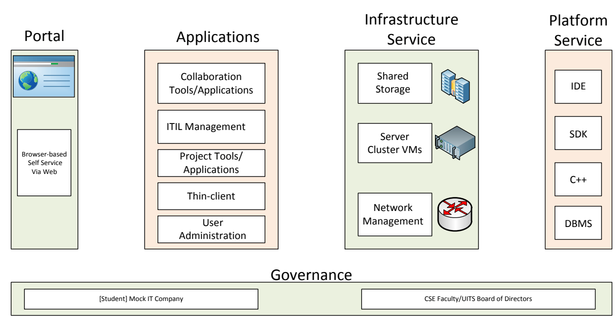

Figure 2: Southern Polytechnic State University Proposed Cloud Architecture for Academic Research and Education

Tier three infrastructure services (i.e., IaaS) provide for shared storage, virtual machines, and network security and traffic management. PaaS is represented in the fourth tier and can provide development, testing, and experimentation platforms for a variety of environments (e.g., an Integrated Development Environment, Software Development Kit, or Database Management System). A proposed governance substrate explores the use of student-led mock Information Technology organization reporting to a jointly composed University information technology and school faculty board.

7. CONCLUSIONS

Support for Research and Education
Based on data analysis and findings from this preliminary baseline study, the researchers concluded the following:

(i) existing cloud computing infrastructure can be advanced to promote applied instruction in the School of Computing and Software Engineering and others based on the interdisciplinary study of information technology and systems;
(ii) construction of an ARN to promote testing, development, and research can best leverage cloud computing resources;
(iii) the proposed cloud architecture is feasible, scalable, and tractable; and
(iv) further study is indicated to fully assess and implement cloud computing in support of interdisciplinary approaches to information technology and systems.

Next Steps and Follow-on Study

Conclusions in this study will be used to advance the research track by informing design of the ARN to access and interoperate with cloud computing resources, including the central University information technology infrastructure, School of Computing and Software Engineering Data Center, and School of Architecture and Construction Management Computing Center. This separate and distinct network initially will be challenged to support School of Computing and Software Engineering and School of Architecture and Construction Management faculty and students and ultimately interdisciplinary studies of information technology and systems University-wide.

The follow-on studies for this research track involve best practices in integration of cloud computing and instructional design (McCrea, 2009), use of cloud computing to evolve innovative paradigms of instruction (Pocatilu, Alecu, & Vetrici, 2009; Pocatilu, Alecu, & Vetrici, 2010), and examination of global research and education capabilities and opportunities via an ARN supported by cloud computing (Lazowska et al., 2008; Liyoshi & Kumar, 2008). The researchers will advance the research track through expanded university involvement, construction of an ARN to provide services and shared resources, and promotion of the interdisciplinary nature of information technology and systems.

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Information Technology Management: Course Re-design Using an Assessment Driven Approach

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Abstract

One of the core courses in the IS2010 Model Curriculum Guideline is *IS Strategy, Management and Acquisition (ISMA).* The authors redesigned their pre-IS2010 model Information Technology Management (ITM) course to meet the skills development stated in the ISMA course. Since the IT discipline is changing rapidly, the technical content in the course needs constant refinement. Instead of starting with learning outcomes and related content for the course design, the authors suggest that the design process could start with learning outcomes and assessments and provide a broad content list with specifics determined by the assessments. They adapt a combination of ideas found in software product development for their evolving course redesign by focusing on assessments in the course. In this paper, the authors apply the test-first principle from agile system development for refining their ITM course to meet the academic intents of the ISMA course. They discuss all aspects of their redesigned ITM course resulting from their initial offering.

Keywords: IS2010 model curriculum, IS Management course, CS/CIS and MIS programs, Adaptation of Software Development and Testing Models

1. INTRODUCTION

The *IS Strategy, Management and Acquisition* (ISMA) core course in the IS2010 Model Curriculum (Topi, et al., 2010) is intended to provide the skills for managing and using IS effectively in any application domain. In addition, it also emphasizes the strategic use of IS for realizing competitive advantage (Pearlson & Saunders, 2010) and the service aspect of the IT function in an organization. At a higher level, the course needs to address infrastructure (technology), application (IS) and practice (management). The specific topics/elements under these three areas change over time. For instance, as the technology changes, a manager of an IT function faces different challenges every year (Gartner, 2012). From the course design perspective, this makes it more difficult to specify the exact topics to be addressed in the technology area. Even the other two areas, IS delivery and key issues to manage, vary with time due to changes in technology and practice. However, the generic concepts in all three areas are technology independent (Pearlson & Saunders, 2010).

The ITM course at the authors' institution was originally developed using the IS2000 Model Curriculum Guidelines and taught in a face-to-face format only. There were two primary reasons behind redesigning our program's ITM course. First, our CIS program is currently being redesigned to apply the curriculum recommendations presented in the IS2010 Model Curriculum. The second reason behind the modification is that we saw the need to offer the ITM course at our university online. In this paper, we describe the approach we took in the redesign process and present the observations from the first offering of the redesigned course.

We first provide a literature review concerning the characteristics of the ITM course as specified in the IS2010 Model Curriculum. A summary of the test-first principle in agile methodology briefly explains the ideas behind the use of this principle in the redesign of our ITM course. We then discuss the requirements of the course through a set of learning outcomes and the different types of assessments such as forums, homework, assignments involving research case analysis, and fieldwork for demonstrating the achievement of those learning outcomes. A list of broad course content is then provided as examples of the exposure needed for carrying out these assessments. Finally, we share the results of the first delivery of this redesigned course along with the end-of-course feedback from students. Suggestions from the feedback will be used for further refinements in the next cycle of course redesign.

2. LITERATURE REVIEW

We start our review by looking at the characteristics of the ISMA course that is specified in the IS2010 Model Curriculum. We then examine the skills specified for the ISMA course and how some IS programs are offering this course at their universities. This was done to help ensure that we developed an appropriate set of learning outcomes. Next, we summarize the test-first principle whose ideas are used in the redesign of our ITM course.

2.1 Nature of ITM

The IS 2010 Curriculum Guide provides a structured foundation for universities to use to develop and revise stronger IS programs. Based upon periodic reviews, the IS Curriculum Task Force came up with the current IS2010 model curriculum (Topi, et al., 2010) that is flexible, domain-independent and well structured. IS2010 specifies a set of structured outcome expectations starting with high-level IS capabilities which are translated into three categories of knowledge and skills: foundational, IS specific, and domain fundamentals. These capabilities provide the educational foundation for the seven core courses forming an IS program:

1. Foundations of Information Systems
2. Data and Information Management
3. Enterprise Architecture
4. IS Project Management
5. IT Infrastructure
6. Systems Analysis and Design
7. IS Strategy, Management and Acquisition.

The overarching framework provides a list of specific IT knowledge, development and management skills that should be addressed in CIS program courses. Although many of these skills will be gained in multiple classes, the focus of this paper centers upon the seventh core course, "IS Strategy, Management and Acquisition." Those skills specifically focusing upon the IT skills needed by IT managers include the abilities to:

- Identify and design opportunities for IT-enabled organizational improvement;
- Analyze trade-offs;
- Manage ongoing information technology operations;
- Provide leadership and collaboration;
- Communicate effectively;
- Negotiate;
- Analyze and think critically in a creative and ethical manner; and
- Evaluate performance within a domain (Topi, et al., 2010).

A number of IS programs currently exist throughout the US and in universities in other parts of the world, listed under, perhaps, a variety of names. Several offer a course equivalent to the IS Strategy, Management and Acquisition course. Although it is relatively easy to find the description of these courses online, obtaining the course syllabi is more involved.

Georgia State University offers a course entitled "Management of Information Services" which appears to be in line with the seventh course of IS2010. In this course, students gain an understanding of "information systems planning, managing the information system infrastructure, justifying the information technology investments, the costing of services and networks, evaluating information system performance, alternative information system delivery modes, managing distributed and end user computing projects and operations management, systems security, and the management of information system professionals. (GSU, 2012)." Students' performance in the course is evaluated through exams, a paper, and class participation (GSU, 2012).

The University of North Carolina – Wilmington offers a course that seems similar to ISMA entitled "Information Analysis and Management" (MIS513). In this course, students gain knowledge about adding value to business through effective IT strategy, are exposed to community IT leaders, learn about IT Return on Investment and Total Cost of Ownership, and learn about IT management skills from the business and IT departments' perspectives. Application of concepts is provided through case analyses and role playing, homework assignments and situational projects (UNCW, 2012).

Appalachian State University has a course with a description similar to that of the ISMA course. In their "Strategy and Ethics" course (CIS 4620), students are exposed to the skills needed by an IT manager to lead an information systems organization. Students examine the role of IT in fulfilling business objectives and their impact on the organization as a whole as well as the role of the individuals involved in the process (ASU, 2012).

Quinnipiac University also offers an IS strategy course aligned with the characteristics of ISMA entitled CIS 600 – "Information Systems Strategy." According to the description of this course, students "…develop the ability to analyze and identify opportunities to improve the effectiveness of organizations through the use of appropriate information technologies. Technologies that influence organizational strategies, structure, risks and processes are emphasized" (Quinnipiac, 2012). Thus, this course also addresses some of the skills needed by the individuals responsible for organizational IT management.

From the above observations, the scope of the ISMA (in our case, ITM) seems to include the strategic and management aspects of IT deployment in an organization. In section 3, we present suitable learning outcomes that reflect this determination.

2.2 Agile Development Methodology - Test-First

We consider that ideas from the system development process can be adapted to the design of courses. Learning outcomes are the requirements of the course. We focus on the assessments that help demonstrate achievement of these learning outcomes. Hence, we find the agile methodology, where test-first is a key principle, more appropriate to adapt for our course redesign approach. We provide below, a very brief summary of the agile methodology and how this model has been used in areas other than system development.

As members of the computing science field, we are familiar with numerous models used to lend form and structure to the software development process. We encourage our students to learn and use these tools to develop a thorough, methodological approach to development from gathering business requirements to feedback and project closure. There are a number of approaches that we teach including the Waterfall model, prototyping, incremental approaches, the spiral model, object oriented programming as well as more time-sensitive approaches such as agile methodologies.

One of the foundational principles behind the "Agile Manifesto" (2001) states "At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly." Thus, one can see why the value of applying agile software development-based methodologies outside the realm of programming has not gone unnoticed (Bradley, 2009; Nanau, 2008). This test and evaluate principle, provides the underlying motivation behind its use (Figure 1). The process of identifying small goals, collecting and processing data about the progress towards those goals, and then evaluating the progress and acting upon the evaluation results has been found to be beneficial in multiple capacities.

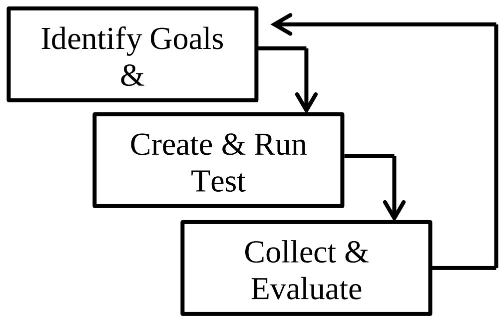

Figure 1 - Agile Methodology for Course

Bradley (2009) described the use of agile assessment methodologies to address program deficiencies identified in a reaccreditation review by the Higher Learning Commission (HLC). Bradley (2009) noted, "The HLC team's recommendations suggested:

- Developing measurable learning outcomes
- Obtaining quantitative data … [permitting] measurement
- Creating feedback loops … [allowing] … faculty to enhance education effectiveness through curricular and pedagogical improvement… (p. 10)".

Bradley (2009) further mentioned that elements of agile methodology assessment and feedback were used in multiple fields, including social work.

In Nanau's article (2008) regarding quality and agile software development methodologies, the author noted the importance of incorporating quality-enhancing measures into the process and how agile methodologies lent themselves well to this mindset. Rather than focusing upon the quality of the final product, the author suggested that the quality of the entire process and underlying sub-processes be analyzed and improved during the development process (Nanau, 2008). Agile development's employment of swift, cyclical iterations meshes well with multiple domains and areas undergoing process improvements.

This notion was evident to IBM's Center for Advanced Learning as they realized the value of agile methodologies to enhance their corporate educational programs. IBM was faced with the challenge of providing up-to-date, work-embedded, social training delivered in a variety of platforms to mobile employees (Groves, et al., 2012). While they formerly had used the sequential ADDIE (analyze, design, develop, implement, and evaluate) process to produce learning resources, they found the speed of agile methodologies to be more accommodating (Groves, et al., 2012). IBM, much like universities of higher education, found that learning design, technology, and the learning experience were changing (Groves et al., 2012).

2.3 Course Redesign

The first motivation for our program's course redesign was the inclusion of the ISMA course in the IS2010 Model Curricula. The second motivation had to do with offering this course on-line. This aspect mainly affected the facilitation process - affecting the way in which learning outcome assessments were to be carried out - rather than the course requirements and the nature of assessments. We provide a brief summary of the redesign process on the on-line course.

Current economic conditions are forcing many colleges and universities to find ways to operate more efficiently with decreasing numbers of resources. The current term associated with this move toward increased effectiveness, on the campus of the authors' institution, is "Course Redesign." Our university defines Course Redesign as "the process of redesigning whole courses to achieve better learning outcomes by taking advantage of the capabilities of information technology…" while getting students actively involved in the learning process (CSTL, 2012).

The process of redesigning courses, at the authors' institution, emphasizes the use of readily available software, opportunities for on-demand education provision, individualized student assistance, multi-mode instructional tools, greater use of automated course assistance resources such as online homework tools, quizzes, and exams, and a heavy emphasis on assessment and monitoring of student learning outcomes.

Thus, the idea centers upon engaging the students in the learning process with the assistance of information technology. Our university caters to students in 25 counties. The goal of the redesigned course is to efficiently teach more students through greater use of technology while effectively meeting educational goals. Goal achievement is monitored through multiple assessments over the course of the learning process.

2.4 Test-First Philosophy of Agile Programming

The test-first philosophy of agile programming lends itself well in the redesigning of courses to provide a more outcome-based, learner-centered approach to education. Tort, Olive, & Sancho (2011) noted that, in applying Test-Driven Conceptual Modeling to the development process, three kinds of tasks are utilized: (1) a test is written that should be passable, (2) the schema may need to be changed to pass the test, and (3) the schema may need to be refactored to improve its qualities.

Applying this test-first principle in course design leads to consideration of the major assessments used to address the concepts. The content is identified to ensure that there is enough exposure to the essential background material for carrying out these assessments. A variety of assessments can then be planned and administered including forums, homework, major and minor assignments (both individual and team-based), presentations, quizzes, and exams. In the following section, the authors describe the student learning outcomes (SLOs) for the ISMA course equivalent at their university, Information Technology Management (ITM), as well as the assessments that have been used in their test first approach to learning.

3. LEARNING OUTCOMES AND COURSE ASSESSMENTS

As described in Section 2.1, the IS2010 Model Curriculum designates specific skills to be addressed in the ISMA core course. In this section, the authors illustrate how they have addressed those skills in the description of the course at their institution in terms of student learning outcomes. Opportunities for students to develop and demonstrate these skills are made available through associated assessments.

3.1 Student Learning Outcomes

As part of the authors' university approved syllabus format, course syllabi must contain a section (entitled "Learning Outcomes") describing what students can expect to learn once they have successfully completed the course. From the discussions under section 2.1, we realize that the ITM course addresses the strategic management aspects of deploying IT effectively. Identification of strategic application is the starting point. In this, knowledge of current technological developments – both hardware and software – from the deployment point of view has a significant role. Managing the development or procurement of applications and the operations relating to the delivery of IT services is an important component. With these thoughts in mind, the following learning outcomes were identified for the authors' ITM course. By the end of the course, students should be able to:

1. Identify the scope of and key issues in IT Management
2. Apply strategic framework analysis tools for identifying strategic IT solutions for an organization
3. Evaluate computing platforms and communications networks from planning perspectives
4. Evaluate strategies for implementing (acquiring) IT-based business solutions
5. Examine customer service and information security management issues
6. Develop an IT strategic plan (an additional requirement for the students taking the course for graduate credit)

While the above student learning outcomes (SLOs) consider technical and managerial skills the course addresses, the course includes additional SLOs to address professional skills. By the end of the course, students should be able to:

1. Work in a team environment, prepare and present a consultancy report for an IT unit in an organization with suggestions for improvements.
2. Prepare a technology appraisal report highlighting the application of recent technological developments.

From the course design point of view, the SLOs are the requirements. Skills associated with the aforementioned SLOs are to be learned over the course of the semester. Applying the agile development approach to course redesign, the following subsection describes the assessments and deliverables that were identified for this course

3.2 Assessments and Deliverables

A combination of both small and large assessments was developed for the course requiring the students to complete the work both individually and as members of teams. The course assessments are listed in Table 1.

Table – 1: Assessment

Assessment
Homework
Forums
Strategic Framework Analysis for an Organization
Technology Appraisal (Infrastructure)
Case Study Analysis – IT Solution Implementation/Acquisition
Consultancy Report for an IT Unit
Strategic Planning for an IT unit (for Grads)
Exams – 2 (Mid-term and Final)

3.2.1 Frequent Small Assessments

With the online course delivery format, smaller assessments, such as homework and forum submissions, are essential to the learning process. These types of small assessments help to ensure that the online students keep up with course content coverage, learn the concepts being addressed, and are introduced to recent technology trends. These assessments can be easily modified in future course offerings to accommodate current technical news and events, as well as changes in technology and industry practices beyond the textbook. Thus, these small assessments help to ensure the currency of the course while, at the same time, providing a means for applying the test-first concept. Students are forced to look for recent information, not necessarily available in a textbook, for addressing these small assessments in a timely manner. Samples of the small homework and forum assessments are provided in Appendix-A.

3.2.2 Large Longer Term Assessments

The bigger, longer term assessments are designed to ensure the development of practical skills. Descriptions for each of the large assessments are provided below with individual assignment descriptions provided in Appendix-B.

Strategic Framework Analysis: In this assessment, students use strategic models to analyze a business and evaluate their application of IT to operations. Students gain an understanding of the strategic frameworks as they work to develop the deliverable for the assigned project.

Technology Appraisal: In this assessment, students gain valuable knowledge about new technology as they study and research a topic of their choosing. Students must understand the technology well enough to write a thorough report, make a presentation to the class, and answer audience questions about the topic.

Case Study Analysis – IT Solution Implementation/Acquisition: This long term assessment asks students to read three separate system analysis and design cases and determine the reasoning behind the three different case outcomes. Students examine the cases from the perspective of: what went right, what went wrong, what could have been done better, what should be kept for future implementations, and what could be done to correct the situation.

Consultancy Report for an IT Unit: This longer term assessment is to be completed by teams of two students. In this assessment, students gain both technical and professional skills by visiting the IT department within an organization and evaluating its operations. Students analyze and assess the operations in order to write a detailed report and provide a presentation.

Strategic Planning for an IT Unit: Students work in teams to visit and analyze the IT operations at an organization of their choosing. They essentially apply and build upon the skills that they have gained throughout the semester as they completed previous assessments. Teams develop a detailed strategic plan that can be administered for their client and then present their findings.

3.2.3 Exams

The two exams included in the course each consist primarily of reflective questions designed to apply concepts to real-world situations. For instance, some of the questions centered around cases that focused on the importance of applying standards during system development, the role of steering committees in strategic IT deployment (rather than focusing on current operation issues), and the importance of maintaining currency in technical areas through training and professional development.

4. COURSE TOPICS

Based on the Student Learning Outcomes for the course and the major assessments used to address those SLOs, a list of high-level topics was prepared. Initially the topics considered included:

1. Strategic frameworks (for IT deployment in an organization)
2. IT Infrastructure (computer hardware and communications networks, and related technologies)
3. Planning and control techniques for IT-based solutions/application development
4. Current trends in the provision of IT services to customers.
5. Issues relating to Information Assurance and Personnel (Human Resources)
6. IT Strategic plan (for graduate students)

A delivery plan for these concepts with additional details is provided in Appendix-C. The content of the assessments assist in determining the specific sub-topics to be addressed for each major concept. For instance, three specific models are considered under strategic frameworks. The second topic is broad as it is intended to provide an overview of the basics of both computer and communication technologies and system software and database management. It is also important to incorporate an exposure to current trends during the course. The web sites of certain textbooks (for instance, Turban and Volonino, 2011) include technology guides for topics such as computer hardware, telecommunications, software (systems and applications), data & database, and systems and analysis. The assigned forum assessments and homework questions required the students to learn and assess recent and important developments in IT infrastructure. For instance, the forums/ homework contained questions on QR and RFID and their implications for future business services and strategic applications.

5. RESULTS OF FIRST DELIVERY

The first offering of the redesigned ITM course was offered online during the Spring 2012 semester. Sixteen students were enrolled in the course including two students who were taking the course for graduate level credit. The 14 undergraduate students included 4 CIS majors and 10 business majors. The course was offered purely on-line.

At the end of the course, students were asked to rate their levels of skill development and knowledge acquisition for the online ITM course. The five-point Likert scale survey questions focused on the six learning outcomes described in Section 3.1. (The response range included: 1. definitely disagree; 2. disagree; 3. not sure; 4 agree; 5.defintely agree.) On average, the students considered that the course helped them in learning how to apply strategic frameworks for identifying systems of strategic nature, evaluating strategies for building/acquiring IT solutions, and identifying key issues in IT management. The higher ratings in the last two learning outcomes could be attributed to the opportunity they had in preparing consultancy reports for real organizations instead of carrying out an assignment based on case studies.

Although the response rate was only 50%, students' responses provided valuable feedback for future course offerings concerning both course content and online facilitation. The learning outcome results (from the five-point Likert scale) are presented in Table-2.
Feedback from the survey respondents indicated that many students would have preferred to take this course in a face-to-face format. This opinion may be a result of the students feeling that the course lacked necessary interpersonal interaction. At present, we are using a home-grown Learning Management System (LMS) that may not provide the interpersonal support that commercial versions provide. Our university is preparing to transition to a commercial LMS product within the next two years.

Table-2: Student Perceptions

Learning Outcome	Rating
Identify scope and key issues in ITM	4.1
Apply strategic framework	4.0
Evaluate new technologies	3.9
Evaluate strategies for building or acquiring IT based solutions	4.1
Examine customer service and information assurance issues	4.4
Develop an IT strategic plan (2 MBA students)	4.5

In the consultancy assignment, students worked in pairs. This assignment could be carried out better if both students could visit the organization that they were studying. In many cases, only one of the students in the team was able to visit while the other took part remotely. Offering the course in an on-line format thus had an impact on students' perceptions. However, these difficulties could be overcome through appropriate tools.

Examining the students' performance in the various assignments, six of the sixteen students turned in consistently professional work. Most of the students responded well to three of the five major assessments: strategic framework analysis, case study analysis relating to system development/acquisition, and consultancy report. These are important skills that are to be attained from this course. Some students indicated a desire to have more discussion on technology while others felt that the course material was rather extensive. In addition, some students seemed to have enjoyed the research-intensive nature of the course. Students also seemed to enjoy the opportunity to interact with real-life professionals for the consultancy report assessment. Quite a few suggestions from the students focused on increasing the levels of interaction as well as incorporating audio/video files with the PowerPoint slides. The feedback was very valuable in directing future course offerings and improving the online format. However, the key takeaway from the survey responses was that a greater level of interpersonal interaction needs to be incorporated into the course in the future which could be accomplished via the use of webinars and audio clips to go along with the PowerPoint slides.

6. FUTURE WORK AND CONCLUSION

In addressing the requirements of the IS2010 Model Curriculum for the ISMA core course, we took an assessment driven approach for the redesign of our ITM course. This approach is conceptually similar to the test-first principle used in agile system development methodology. The learning outcomes are analogous to the system requirements and the assessments, to the tests.

It is important to note that we started with the SLOs first (which are the course requirements) and then designed the appropriate assessments to help achieve those outcomes. Six broad topics were identified (section 4) to acquire sufficient knowledge to carry out these assessments. This was a departure from selecting the topics first in the course design process.

In this course redesign, the focus was on assessments appropriate for achieving the learning outcomes. A variety of assessments were used in this course with increasing complexities. We were able to make use of our experience in facilitating the capstone project course where we use client-sponsored projects in designing two assignments that involved studying real organizations. The consultancy report for all students and the strategic system planning report for the MBA students certainly helped the students in achieving the goals of this course. Redesigning the course for on-line offering required considerable changes to both the facilitation process and the types of assessments administered. We found the assessments driven approach to be valuable for redesigning assessments and course content. However, we still need to address the facilitation issues when offering the course on-line. Availability of a full-featured LMS and considerable training in using the LMS are essential to successful online course offerings. In our first offering of the redesigned ITM course, the students responded favorably. Through survey feedback, we realize the importance of increasing the level of interaction throughout the course.

In the face-to-face version of the course, the main assessment around which the course focuses is studying the operations of an IT unit and preparing a consultancy report for possible improvement. In the redesigned online version of this course, we were able to maintain this significant assessment with minor modifications. While most students responded well to this very demanding assessment, a few had difficulty in identifying a client organization and collaborating properly. Some pre-planning (identifying organizations for such studies before the course starts) is in order for future offerings.

In this paper, we discussed the first iteration of the cycle in designing and delivering a course on IT Management. Based on student feedback, further refinements will be made to the course content, assessments and the facilitation process. Since the requirements may not change that frequently, such refinements in the second cycle of the redesign will be minor and mostly confined to the facilitation process. If this course is offered on-line again, additional methods of interpersonal contact will be incorporated throughout the course.

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Editor's Note:

This paper was selected for inclusion in the journal as a ISECON 2012 Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2012.

Appendix-A: Smaller Assessments (Homework and Forum Topics)

Assessments consist of Forums, Homework, and Assignments. Sample assessments are presented below.

I. Forums: Sample Forums:

1. **Forum 0:** Introduction: Students introduce themselves
2. **Forum-1:** Discuss how the 2D codes (e.g. QR – Quick Response) in conjunction with other technologies (like mobile) could be used in different businesses. In particular, focus on possible strategic applications.
3. **Forum-2:** Technologies that influence developments in IT
   Listed below are some of the technologies. Not all of them are to do with computing. However, these technologies influence developments in computing technology. I want you to discuss in Forum-3 on how any of these technologies is affecting / influencing the developments in computing and communications technologies. The book may not discuss these technologies; so you have to use other resources (especially web) for finding appropriate information.
   Technologies: Fibre Optics, Optical Data storage, Internet & Web, Photovoltaic cells, Nanotechnology, Micromechanics, Microwaves, Advanced Satellites, Lasers, Superconductors, Biotechnology, Genetic Engineering.
4. **Forum-3:** Discuss RFID and its uses (focus on its practical applications)
5. **Forum-4:** ERP. Many organizations started using ERPs during the Y2K time period. You may discuss the different aspects of ERPs; what do they have in them; what are some of the ERP products available on the market; the pros and cons of using such systems.
6. **Forum 5:** System Development Methodologies. Compare the agile approach with the conventional heavy-duty system development approach. Discuss the strengths and weaknesses.
7. **Forum 6:** Services. Discuss some of the annoyances a help desk faces
8. **Forum 7:** Security. Discuss the roles of organizations such as NSA, SANS, CERT, NIST

II. Homework:

Considerable reading assignments were assigned every week as part of the homework assessments. Students were asked to submit answers to specific questions from reading material. Reading material consisted of technology guides on computer hardware, telecommunications, software (systems and applications), data & database, and systems and analysis; handouts on strategic framework and systems development; publications on ERP implementation, and project management.

Example Homework: Computer and Communication Technology
Study the two tech guides on computer hardware and telecommunications (and data communications).

1. Describe two ways in which we could integrate the mobile devices and Tablet PCs in a work environment (or in a class-room situation).
2. Briefly describe two applications for supercomputers.
3. What are some of the advantages of using fiber-optic cables in communications? Make sure to include its important characteristics in your discussion.

Appendix-B: Larger Assessments

Assignment-1: Application of Strategic Frameworks: Due on:

Introduction
The organization you will consider in this assignment is Charles Schwab Corporation. Use material given in class. You will apply the Value Chain Model, Five-Forces Model, and Weisman's Model to analyze Schwab and discuss the application of IT in Schwab. Use additional material for gaining a better understanding of the application domain (may be needed for value chain). Specific outputs: Value Chain Model 20%; Five Forces Model,30%; Wiseman's Model 30%; Discussion (2 pages 20%)

Assessment-2: Technology Appraisal Report: Due on:

Introduction
IT management looks at two aspects: technology and its relevance to business. We need to know what a technology is, how it works, what are its limitations, its pros and cons in relation to other technologies, and its viability for business applications (i.e., its potential to serve as part of a business solution). So here is an assessment to let you explore the world of technology!

Tools and assignment

In this assessment, you will study one new / emerging / refined technology of your choice in computing or communication (hardware or software or practice) area. You can pick up a topic from the IEEE spectrum magazines (library resources) for this exercise. If necessary, you will explore the topic further using the web and other sources. You need to present the material you have learned to the class (10 minutes). You will also summarize your research in a technology appraisal report (5 pages) highlighting its relevance in IT management. The report should be in your own words. Specific output: Presentation: 20% and Technology Appraisal Report 80%

Assessment-3: System Development – Case study analysis

Introduction
System development is a complex process. Several projects have failed in the past. In this assessment, you will examine three cases in systems development and answer the following six questions.

(Note: We do not list the cases here. However, one case is about a successful system development; second system is considered a failure; and the third system was developed by students in their capstone course. Questions relate to system architecture, strategic partnership in system development, development methodology, interaction between stakeholders, what went wrong in a project, and possible remedial actions)

Assessment-4: IT/IS Review Consultancy – Assignment:

Introduction:
This assignment is concerned with the review of IS/IT Services in an organization (medium or large) of your choice. The focus will be on the Operation and Support Services aspects. In this exercise, you will study the IS/IT Services and prepare a Review Report highlighting the major strengths and identifying areas requiring improvement. A content list for the Review Report is given below. You will also make a presentation (20 Minutes) of your findings to the class. You will provide a brief (3-pages) handout to participants that summarizes your presentation.

You will carry out this assignment with one other student. You will jointly submit a single report and jointly make the presentation. (Professional appearance is necessary for your visits. Remember you are representing the University and the company could be a prospective employer.)

Description of Tasks:
Choose an organization that has an IS/IT Department. Collect information on the Computing and Communication Network and Applications Architecture provided by the IS/IT Department. Review the IS/IT Operations and Support Service functions. Your review report will contain a(n):

- Executive Summary

- Observation
  -- Brief Description of the hardware facilities (computers, networks, and platforms)
  -- Brief Description of the application systems (structure of applications)
  -- Organization of the Operation and Support Service functions
  (For all the above three, use suitable diagrams.)

- Assessment (your own) concerning
  -- Performance of Customer Support function
  -- Key Information Assurance Measures in Place
(Here use the concepts you learned in the course regarding customer service and IT security)

- Recommendations for improving the IS/IT Operations / Services

Distribution of Points (Total Points:100)

Review Report:	80		Presentations:	20
Summary		10		
Observation		30		
Assessment		25		
Recommendations		15		

Assessment 5 (For Grad Credit):
Strategic Planning Consultancy Report and Presentation

Introduction:
This assignment is 20% of your assessment for the ITM course. You will work in a group (all the members get the same points) for this assignment as it involves fieldwork. It is concerned with the preparation of a strategic plan for the IS/IT function in an organization (small to medium size) of your choice. (Consider a specific unit, if it happens to be a large organization.) In this assignment, you will get an opportunity to apply the implementation issues pertaining to IS strategic planning. The tasks include identifying strategic system(s) in the business context, repositioning of IS/IT function (to use the system properly), and preparing IS/IT strategic plan and delivery plan for the system solution.

Description of Task:

Choose an organization that has an IS/IT Department. First, identify a strategic information system in the business context. Carry out an initial investigation for preparing a Strategic IS plan in line with the Organization's Mission. Carry out the necessary activities leading to the preparation of the Strategic Plan Report that includes the implementation of the identified strategic information system. These could be: mapping of current and future architectures for infrastructure and applications, developing Migration Plans including reorganization of the IS/IT unit; and preparing a change management plan for using the implemented system, and the delivery plans for the implementation of the strategic system. You will also present the highlights of your report to the class.

1) Strategic Plan Report (Preparation of a report that includes the following topics): (80%)
- Executive Summary
- Brief description of identified strategic information system (or strategic application of Information Technology)
- Existing systems and proposed application (application area and technology infrastructure)

- Analysis of the chosen strategic information application using frameworks such as Five force/ Wiseman and/or Value Chain
- Cost and Benefit Summary (estimates) for the proposed system
- Organizational change management plans (to realize the system benefit)
- Delivery Plans for the proposed system.
- Guidelines (and criteria) for reviewing the implemented system after a year.

2) Class presentation of highlights of the Report (20%)

Appendix –C: Concepts

Introduction: Progression to an Information-age and IS/IT growth; Strategic importance of IT; Processes in IT; Key IT Management issues
Business Solutions Planning: Corporate Information System Architecture; Strategic frameworks, Contents of a Strategic Plan
Impact of Computer Platforms in Planning: Applications & Tech. interactions; Computer platform planning {Application of Strategic Framework Assignment}
Impact of Communications in Planning: Communications Networks: Network planning
Applications Development Management: Software Engineering concepts, IT Project Planning and Control {Technology appraisal report and presentation}
Alternatives Applications in System Development and Acquisition Management (Mid-Term)
Operations and Maintenance Management: Network & Application Systems Maintenance {Case Study analysis report relating to system development and acquisition}
Service Management: SLA, User Support; Performance monitoring
Change Management: User and IT responsibilities
Information Security Management: Aspects of security, Risk
ISM: Control and protection– Information Assurance and Contingency planning
Human Resource: Teamwork, Professional Consultancy report on a real-world IT Operation and Strategic Planning (for Graduate credit only)
Final Exam

Strategic Plan for Enhancing Online Learning

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Abstract

E-learning has evolved over the past years with many universities following the growing trend of incorporating online courses into their institutions. This four year public institution has not been left behind in its quality enhancement plan (QEP). QEP is designed to enhance online learning resulting in an E-focused environment. Surveys of faculty and students at the institution, however, show the potential difficulties faced in online learning. Inadequate training, lack of motivation, and poor time management are some of the major factors affecting student performance. This study assesses and investigates the progression of online learning and proposes approaches to enhance online learning. Data was collected to compare campus-based and online courses and monitor their progression over the years. Campus-based courses still have a higher pass rate than online courses, with an increase in passing rates over a three year period. The results serve as a baseline for improving online learning procedures and outcomes over the next five years.

Keywords: Online Learning, Assessment, Orientation, Student, Instructor, Institution

1. INTRODUCTION

Currently, the predominant method of distance-based course delivery is by online means. With increased accessibility to and affordability of the technology required by this method, students are taking advantage of online course offerings in ever greater numbers. Dialogue between the course instructor and students is readily facilitated by the technologies currently employed by distance education programs. Although the growth in course offerings by online means is rapid, some 4-year universities are still reluctant to implement programs on a broad scale. In fact, the majority of growth lies with 2-year associate degree-granting institutions, which have accounted for over one half of enrollments in online courses in the last 5 years. In regard to the future, the primary goal among university administrators is finding a niche for distance education within universities. With the advent of online education, this mission is critical, as the majority of adult learning occurs through self-directed study. Students, especially nontraditional students, are more likely to enroll in the coming years, as online classes afford flexibility and autonomy. However, faculty must be supported and rewarded for their contributions and continually trained in equipment use and "best practices" in course delivery and instructor-student interaction. Stand-alone modules, which rely on simulations and multimedia via the Internet and less on interaction with instructors, will continue to be developed and implemented. Online distance education will continue to grow and develop as it affords students the opportunity to solve problems and master the fine details within their chosen field of study through intensive interaction (Gaytan, 2007; Larreamendy-Joerns Leinhardt, 2006 as cited in Dobbs et, al, 2009).

The traditional classroom has long been considered the standard of educational venues, but recent technological advances have brought a dramatic rise in educational offerings over the Internet. Many universities recognize the capability of this technology to increase student enrollment, resulting in the development of many new courses and even the awarding of college/university degrees using online techniques. For students, these online courses permit more flexibility to learn at an individualized pace, schedule course work around their personal and professional lives, reduce or eliminate travel time, and provide the opportunity to review course materials as often as they wish (Dobbs et. al, 2009).

Statement of Problem

Online educational programs provide students with an opportunity to receive a degree from a university that may be located at a considerable distance from their homes and/or places of employment. However, disadvantages to online courses do exist. In order to be successful, students must possess a certain degree of technological competence prior to participating in online courses. Student satisfaction with online learning is essential for the learning process to be successful. Online courses may be more demanding for students because they require the student to assume more responsibility for their learning.

Consequently, anecdotal evidence suggests online course completion and program retention rates are lower than for similar campus-based programs. Online courses also present challenges for instructors which suggests that they are time consuming to develop and deliver (Hubble & Richard, 2006).

Moreover, in many cases the institution has inadequate resources available for online learning to progress. Tight budgets often result in lack of available technology and of training for both faculty and students, which make it difficult to implement broad, campus-wide e-learning solutions (Hubble & Richard, 2006).

Statement of Objectives

This study seeks to investigate the progression of online learning at a four year public institution. It reviews the current practices of online learning at the institution and suggests strategies to help enhance online learning. Further, by examining the perception of students and faculty, it reveals the problems faced in online learning. Additionally, this research analyzes freshman grades for 2008, 2009 and 2010 for both campus-based and online courses.

The research focuses on the following questions:

1. What is the perception of students of online learning?
2. What is the perception of faculty of online learning?
3. Is there a difference in grades in online courses over a 3 year period?
4. Is there a difference in grades in campus-based courses over a 3 year period?
5. Is there a difference in grades between campus-based and online course?
6. What steps need to be taken to improve online learning?

2. REVIEW OF LITERATURE

Background of the Four Year Public Institution

The institution began its online learning initiative in 2006 as a way to attract students displaced from New Orleans and scattered across the nation post Hurricane Katrina. Implementing online learning after Katrina has not only allowed the institution to keep its doors open, but it has also allowed the institution to move forward with its mission of providing higher education to students from diverse backgrounds. The four year public institution offers online degrees in Criminal Justice, Early Childhood Education, and General Studies as well as a Master's degree in Museum Studies.

Quality Enhancement Plan

The Quality Enhancement Plan (QEP) is the component of the accreditation process that reflects and affirms the commitment of the

Southern Association of Colleges and Schools, Commission on Colleges (SACS-COC), to the enhancement of the quality of higher education and to the proposition that student learning is at the heart of the mission of all institutions of higher learning.

QEP topic: E-FOCUSED! Enhancing Student Learning in Online Courses by Improving Institutional Readiness.

The QEP will accomplish the following three major goals:

- enhance the performance of first year freshmen in online general education courses;
- enhance the online instructional skills of faculty and staff through regular training and assessments; and
- improve institutional readiness for online teaching and learning.

Enhance the performance of first year freshmen in online general education courses.

Curriculum content must be relevant to the real world as well as facilitate problem-centered learning (Fish & Wickersham, 2009). To give equal importance to both technological usage and actual subject-matter, the instructional design should institute the need to master specific learning objectives outside of class meetings. This focus allows the instructor to assist students in their heurism, rather than demanding their blind obedience. Instructional and course designs interpret this view into planning and implementing of transition course activities from content centered to learning centered (Fish & Wickersham, 2009).

Incorporating new and advanced information technology tools and software such as wiki and AskOnline (an easy-to-use online environment for tutoring) within the online environment, empowers faculty to create effective and engaging presentations through voice animations, which enhances interactivity and communication between faculty and students, and between students.

As a result, many online students develop meaningful connections with each other, which may result in enhanced career networking opportunities in years to come (Lee, 2000; Roper, 2007).

Prior to enrolling for online courses, students should take part in a training session like the Smarter Measure, a web-based tool which assesses a learner's likelihood for succeeding in an online learning program. SmarterMeasure indicates the degree to which an individual student possesses attributes, skills and knowledge that contribute to success in online learning that exposes them to the expectations of in the online environment. This will enhance students' performance by eliminating any anxieties they might have with respect to what is expected of them within an online learning environment. Moreover, introducing a more user-friendly application package within the online learning sphere, and one-on-one tutoring, will help mitigate students' fears and consequently allow them to focus more on their course material than on striving to get conversant with the online architecture, processes, and/or applications.

Enhance the online instructional skills of faculty and staff through regular training and assessments

Online learning in the virtual classroom can present pedagogical and technological challenges for the faculty members in addressing students' learning styles. Research shows that online learning modules that are static provide little interactivity for learners (Cheng, 2008). Faculty members must transform their on-campus teaching style to fit the new technologically enhanced world of e-learning (Rockwell, Schauer, Fritz, & Marx, 2000). This can be done effectively through communicative channels which have allowed instructors to personalize their courses and feedback (Helvie-Mason, 2010). Modules that are properly created help students to remain at a required pace, to keep track of assignment due dates, and to meet students' expectations by providing well-written directions. Online course instructors can be trained to acquire a new set of competences to engage in effective instructional practices. In order for instructors to teach online courses, they should be properly trained to increase their ability in technological competency (Fish & Wickersham, 2009).

Motivation and incentives are additional factors that enhance online instructional skills of faculty. Every successful accomplishment of a faculty who creates an online version of a campus-based course should receive an incentive as a motivation producing efficacy. Efficacious faculty have strong beliefs that they can bring about a change in student learning and attitude (Cubukcu, 2008). If a teacher believes that all students in that classroom are capable of learning, then the teaching style will involve rich standards, quality, and sensitivity to students' learning styles, regardless of the population the teacher serves (Muijs & Reynolds, 2002).

Improve institutional readiness for online teaching and learning

To use online learning effectively, institutions must adapt their pedagogy, enhance the technical proficiency of their users, and develop a reliable and robust technology infrastructure (Arabasz & Baker, 2003). Accordingly, it should continue to be a high priority for the institution to update its technological infrastructure, particularly with high-speed broadband Internet connections; thus, the administration should provide the necessary funds to obtain these software and hardware applications. Moreover, institutions should frequently update their servers and network systems to accommodate for the increasing demands for an efficient, user-friendly and effective online environment. A better technological infrastructure will increase the opportunity for faculty and students to utilize technology regularly for research and collaboration, cross discipline learning projects, and web communication and publication (Lan, 2001).

In examining retention and student success, one of the most important areas to support online learning is student services. Comprehensive student online training is essential. Students need to have support systems in place. One main objective to increase institutional readiness for online learning is to enhance student services for online students (Germanna Community College, 2007).

The delivery of online education provides a greater opportunity to serve more students, to increase enrollment, consequently increasing universities' revenue. Although the influx of students may be encouraging, online education is very demanding (Gibson & Colaric, 2008). Areas of technological deficiencies should be addressed to continue providing quality delivery and assurance in online education. According to Oh and Park (2009), instructional support and technology have been raised as problems with regards to the developing online instructions in many institutions.

Prior to assigning any online class to a faculty, the institution should evaluate and assess faculty knowledge and skills to efficiently and effectively manage an online class as well as provide strong online learning infrastructures (Fish & Wickersham, 2009). The lesson of successful redesign is that many diverse members of the administration and faculty need to work together. Thus, the institution should encourage collaboration amongst faculty.

3. METHODOLOGY

The purpose of this paper is to review and discuss strategies to enhance the quality of online learning and instruction. One important factor in designing an online class is to understand instructors' and students' expectations.

Sample and data collection

Data from the Information Technology Center (ITC) of the institution for campus-based and online courses were used to examine freshman passing rates and failing rates. This includes data for campus-based versus online grade distribution for Introduction to Biology (BIOL 105), English Composition (ENG 111) and Fundamentals of Public Speaking (COMM 210) during the following semesters: Spring 2008, Fall 2008, Spring 2009, Fall 2009 and Spring 2010.

Year	**Course**	**No. of students**	
		Campus-based	**Online**
2008	BIO 105	367	91
	COMM 210	202	59
	ENGL 111	509	136
2009	BIO 105	334	104
	COMM 210	180	58
	ENGL 111	456	61
2010	BIO 105	404	53
	COMM 210	181	43
	ENGL 111	506	93

Table 1: Enrollments by Subject

Table 1 shows the sample size for freshman students registered in the general education course BIO 111, ENG 111 and COMM 210.

In addition, two perception surveys on students and instructors were conducted at the end of the Spring semester in 2010, in which 100 freshman students and 30 instructors responded. The survey consisted of ten statements for freshman students and ten statements for instructors.

Data Analysis of Perception Survey

In the two perception surveys on students and instructors the Likert scale was employed to collect data based on the ten statements. Data analysis was accomplished by using the arithmetic means: $(X= [x_1 + x_2 + x_3 + \dots + x_n]/n)$ to measure the central tendency of the respondents.

Hypothesis

Students and faculty alike face problems in online courses.

Performance of students enrolled in a campus-based undergraduate course is higher than performance of students enrolled in the same course provided online. Performance in online courses (Fall and Spring semesters) increased between 2008 and 2010. Performance in campus-based courses increased between 2008 and 2010.

Findings

Freshman Students and Faculty/Instructor Perception Surveys:

Freshman students were required to mark strongly agree (SA); agree (A); neutral (N); disagree (D); or strongly disagree (SD) in response to the following statements:

1. I have full access to a personal computer and internet.
2. I understand how to access Blackboard which is required to navigate my online courses.
3. I have adequate course assistance from my instructor and the online learning administrators.
4. Software on Blackboard prevents students from cheating.
5. Taking courses online motivates me as a student.
6. Existing factors in online classes frustrates me as a student.
7. I participate in discussion sessions posted by the instructor.
8. Online teaching and practices need improvement.
9. The institution has a motivated and committed online education.
10. Online students need more training and in-service orientation.

Table 2 (see appendix) shows results of the student perception survey which reflects that 96.1% of the students have full access to a personal computer and internet and also understand how to access Blackboard which is required to navigate online courses. Most students (76.5%) agreed they had adequate course assistance from the instructor and the online learning administrators and believe that taking courses online motivates them as a student. Seventy-four percent of the students believe the software on Blackboard prevents them from cheating. Only 33% of them admitted to the fact that existing factors in online classes frustrated them as a student. Eighty-two percent of the students participated in discussion sessions posted by their instructor whilst only 42% agreed that online teaching and practices needed improvement. Most students (72.6%) agreed that the institution was motivated and committed to online education. Only 26.02% of the students believe that online students need more training.

Table 3 (see appendix) shows the faculty's perception of online teaching. Instructors were asked to respond strongly agree (SA); agree (A); neutral (N); disagree (D); or strongly disagree (SD) to the following statements:

1. The expectations of students who earn grades in online learning courses are realistic.
2. The current online learning platform is adequate to enhance student participation.
3. The software currently used prevents cheating in online courses.
4. Online learning is user friendly at the institution.
5. Faculty members teaching at the institution are motivated.
6. There are major factors that frustrate faculty when teaching online courses.
7. Faculty hold adequate discussion sessions in online courses.
8. Online teaching and learning practices need improvement.
9. The institution has a motivated and committed online education.
10. Online faculty need more training and in-service orientation.

Table 3 (see appendix) shows that 55.2% of the faculty agreed that the expectations of students who earn grades in online learning courses are realistic, while 45.4% of them agree that the current online learning platform is adequate to enhance student learning. A slight plurality (52.4%)of the faculty disagreed with the fact that the software currently used prevents cheating in online courses. According to 68.2% of the faculty, online learning is user friendly. Most faculty (63.7%) agree that faculty members are motivated to teach online courses. Major factors are evident that frustrate faculty teaching online courses and 59.1% agree with this statement. Only 42.8% agreed that faculty held adequate discussion sessions in their online course. A large majority, 81.8%, believed that online teaching and learning practices need improvement. Only 50% percent of the faculty agreed with the proposition that the institution has a motivated and committed online education program. Lastly, 72.7% of the faculty agreed that online faculty needed more training and in-service orientation.

Data Analysis of Freshman Grade

Data from the Information Technology Center (ITC) of the institution for online courses were used to examine freshman passing rates and failing rates. SAS and Microsoft Excel 2010 software were used to analyze the data in order to examine the rate of students' passing to failing. A, B, C, and D are passing grades, while F is a failing grade. ANOVA can be used to make inferences about mean grade of students semester to semester between 2008 and 2010 (semester grades present a groups or variables). Since we have more than two groups or variables we can use ANOVA. This includes data for campus-based versus online grade distribution for Introduction to Biology (BIOL 105), English Composition (ENGL 111) and Fundamentals of Public Speaking (COMM 210) with respect to the following semesters: Spring 2008, Fall 2008, Spring 2009, Fall 2009 and Spring and Fall 2010.

4. FINDINGS AND DISCUSSION

Table 4 shows the progression of grades for campus-based and online courses from the year 2008 to 2010.

The p value for the campus-based BIOL 105 course is 0.93; therefore, there is no significant difference in grades for the BIOL 105 campus-based course from 2008 to 2010. The p value for the campus-based COMM 210 course is 0.75. Therefore, there is no significant difference in grades for the COMM 210 campus-based course from 2008 to 2010. The p value for the campus based ENGL 111 course is 0.4436; therefore, there is no significant difference in grades for ENGL 111 campus-based course from 2008 to 2010. The p value for BIOL 105 is 0.0011.

Campus-based courses			
Course	**F- value**	**P-value**	**Significance**
BIOL 105	0.07	0.93	Not Significant
COMM 210	0.29	0.75	Not Significant
ENGL 111	0.81	0.44	Not Significant
Online Courses			
BIOL 105	7.05	0.0011	Highly Significant
COMM 210	0.75	0.48	Not Significant
ENGL 111	2.93	0.056	Significant

Table 4: Progression of Campus-based and Online courses from 2008 to 2010

Therefore the difference is highly significant. The p value for COMM 210 is 0.48. There is no significant difference in grades for the online course between the years 2008 and 2010. The p value of ENGL 111 is 0.056 which is significant at 90% confidence limit with a 0.1 level. Thus, there is a significant difference in online course grades from 2008 to 2010. Table 5 (see appendix) represents the pairwise comparison of the BIO 105 online course from 2008 to 2010. There is a significant difference in grades for BIO 105 between 2008 and 2010 as well as between 2008 and 2009. However there is no significant difference in grades for the BIO 105 online course from 2009 to 2010.

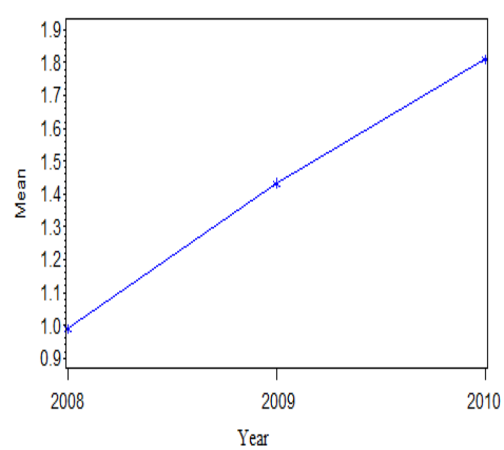

Figure 1: Mean distribution for BIO 105

Figure 1 shows an increase in grades; this is highly significant between 2008 and 2009, not significant between 2009 and 2010, but significant from 2008 to 2010.

Table 6 (see appendix) displays the difference of means of ENGL 111 between 2008 and 2010. There is no significant difference of grades from 2008 to 2009 and 2009 to 2010 but there is a significant difference of grades from 2008 to 2010 when compared at the 0.05 level.
Figure 2 illustrates an increase in grades over the 3 year period; this is not significant between 2008 and 2009 and 2009 and 2010 but significant from 2008 to 2010.

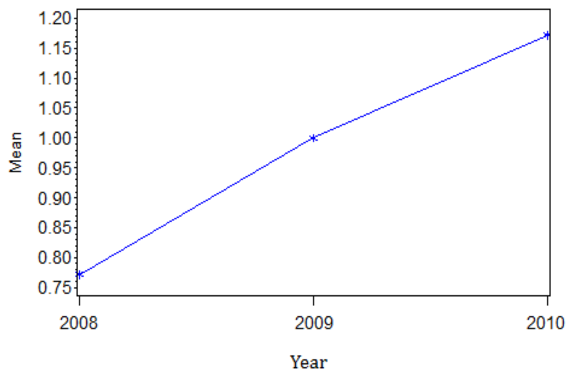

Figure 2: Mean Distribution for Online ENGL 111

Table 7 shows the t-test and p-value for the comparison between campus-based and online courses. The difference for the BIOL 105 campus-based courses and online courses is highly significant, revealing that campus-based is better. COMM 210 campus-based and online course has no significant difference whilst the ENGL 111 campus-based and online course has a significant difference over the 3 year period.

Course	T-value	P-value	Interpretation
BIO 105	3.93	< 0.0001	Very Highly Significant
COMM 210	1.35	0.1787	Not Significant
ENGL 111	2.50	0.0125	Significant

Table 7: T-test comparison between campus-based and online courses

Figure 3 shows a mean of 1.58 for campus-based courses whilst online courses have a mean of 1.36. Therefore, campus-based courses have a higher passing rate than online courses.

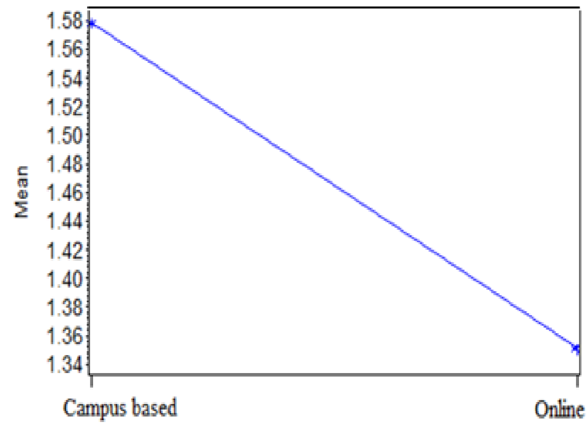

Figure 3: Mean distribution of campus-based and online courses

Figures 4, 5, and 6 (see appendix) show the percentage passing and failing rates for online and campus-based courses in BIOL105, COMM 210, and ENGL 111 respectively from 2008 to 2010 along with student retention. As per the data, in the campus-based BIOL 105 courses, the pass rate was 54% in 2008, 53% in 2009, and 55% in 2010. This shows that there has been a slight decrease and finally an increase in pass rates over the period. On the other hand, the online BIOL 105 courses show a steady increase in pass rates over the same period with 34% in 2008, 47% in 2009, and 64% for the year 2010. The results of the campus-based COMM 210 courses show a pass rate of 71% in 2008, 75 % in 2009, and 74 % for the year 2010. A similar pattern is seen for the online COMM 210 course as well, with 66% in 2008, 72% in 2009 and 71% for the year 2010. The campus-based ENGL 111 courses had a pass rate of 44% in 2008, 43% in 2009, and 48% for the year 2010.The online course results show 29% in 2008, 36% in 2009, and 40% for the year 2010. The passing rates for BIOL 105 and ENGL 111 is lower than COMM 210 for campus-based versus online courses. Overall, the campus-based courses have a higher passing rate than online courses.

PROPOSED MODEL

In order for the institution to fully achieve its QEP goal of being E-Focused, a holistic approach of student, faculty, and institutional readiness

should be adopted. The proposed model illustrates different components that can help achieve this goal.
As seen in figure 7 (see appendix), student readiness involves the accessibility to a computer. A student cannot take an online class without having full access to a computer. A readiness software tool such as SmarterMeasure needs to be administered to all students who desire to take an online course, one which tests the student's readiness to take the course by testing effectiveness in reading, technology, learning styles and typing skills. Ongoing training is another important component that needs to be provided for all students; this training will help educate students on how Blackboard works. Finally, students have to make sure they get intimately involved with the Blackboard environment, making sure there is as much interaction as possible. Time management is a very important component in student success online. Students need to set aside adequate time for assignments, tests and any other work required by the instructor. Instructors can motivate online students by awarding points for the processes online students use in order to arrive at the final answer. Such processes include critical thinking, interaction, collaboration, communication, and application (Reynard, 2008). These components achieve students' readiness.

Instructors need to have full access to updated technology for use in their online classes. In-service training should be provided by the e-learning department on Blackboard usage and curriculum design. The online curriculum should be designed in order to foster collaboration, engagement and student-instructor interaction.

The engagement of students in an online course is especially important because "without intentional engagement of students, little, if any, learning will take place" (Association to Advance Collegiate Schools of Business, 2010). This should include applications such as wikis, discussion boards, chats sessions, blogs, group tasks, and peer assessments. Instructors should have a mechanism in place for time management in online classes. They need to realize that online classes may require constant monitoring in order to respond in a timely manner to students' needs. Finally, constant motivation is needed to keep track with upcoming technology and changing curriculum.

The role of the institution, however, is not to be undervalued; the institution needs to provide up-to-date technology for instructors and students in order to foster the online learning process. Student support services, including library services, disability services, retention office, student counseling, etc., should be available. These are vital parts that help motivate and assist students in their pursuit in online classes. Incentives and continuous support should be given to faculty who embark on teaching an online course to motivate them to continue teaching it. The provision of motivation to faculty that comply with the established online policies to create a successful online learning environment is important. The combination of students' readiness for online learning, faculty readiness for online learning, and institutional readiness for online learning lead to the overall goal of enhanced online learning. Finally, the institution needs to always provide an evaluation mechanism that helps evaluate online course instructors and students. Feedback sought from assessment helps to make the much needed improvement for online courses. These components lead to institutional readiness for online learning.

5. CONCLUSION

Online learning is steadily becoming more popular in higher education institutions. Students opt for online courses in order to have the flexibility in times, especially for working and non-traditional students, as is evident at the institution. The institution's QEP is designed to enhance online learning for students early in the freshman and sophomore years.

The SmarterMeasure assessment is required for students classified as New Freshmen or Freshmen; these students have to take and pass the assessment in order to take a 100% online course.

Analysis of grades for both campus-based and online freshman BIOL 105, COMM 210 and ENGL 111 courses show that both are progressing each year even though it is by a smaller margin. However, the online course in BIOL 105 and ENGL 111 had a significant increase in grades over the 3 year period. When campus-based and online courses in COMM 210 were compared, it was evident that there was no significant difference between the two. This could be attested to the fact that both the online and campus-based course were taught by the same

professor. On the other hand, the BIOL 105 and ENGL 111 campus-based course had a higher passing rate than that of the online course.
Based on these findings, the institution's QEP can be accomplished by increasing readiness of students, faculty, and the institution for such a learning environment. Improving students' skills will enable them to more critically evaluate the learning process and to learn better in the online learning environment. Enhancing faculty skills will make the online learning environment more exciting and conducive to quality learning. Developing strategies for effective course management should be a collaborative effort by both the instructors and the institution. In addition, feedback from the student survey further echoes the need for student training and does not ignore the fact that students are not oblivious to the need for improvement in online teaching and practices. This understanding could help faculty make improvements in the delivery of online courses.

The proposed model incorporates the three elements of student, faculty, and institutional readiness to achieve enhanced online learning.
Results of this study will be evaluated yearly and the weakness will be addressed in order to improve online learning procedures and outcomes over the years.

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APPENDIX
Table 2: Student's Perceptions of Online Courses

Statement	SA	A	N	D	SD
1	86.3%	9.8%	0.0%	2.0%	2.0%
2	86.3%	9.8%	2.0%	2.0%	0.0%
3	54.9%	21.6%	9.8%	13.7%	0.0%
4	50.0%	24.0%	16.0%	4.0%	4.0%
5	54.9%	21.6%	13.7%	5.9%	3.9%
6	11.8%	21.6%	23.5%	29.4%	15.7%
7	54.0%	28.0%	8.0%	6.0%	4.0%
8	16.0%	26.0%	26.0%	22.0%	10.0%
9	37.3%	35.3%	19.6%	3.9%	3.9%
10	3.9%	23.5%	31.4%	27.5%	13.7%
Average	45.54%	22.12%	15.00%	11.64%	5.72%

Table 3: Faculty's Perceptions of Online Courses

Statement	SA	A	N	D	SD
1	9.1%	45.5%	27.3%	13.8%	4.5%
2	4.5%	40.9%	27.3%	22.7%	4.5%
3	0%	33.3%	14.3%	28.6%	23.8%
4	18.2%	50.0%	22.7%	9.1%	0.0%
5	27.3%	36.4%	27.3%	9.1%	0.0%
6	22.7%	36.4%	27.3%	13.6%	0.0%
7	9.5%	33.3%	42.9%	14.3%	0.0%
8	31.8%	50.0%	19.2%	0.0%	0.0%
9	13.6%	36.4%	27.3%	22.7%	0.0%
10	22.7%	50.0%	22.7%	4.5%	0.0%
Average	15.93%	36.23%	25.83%	13.83%	3.23%

Table 5
: Pairwise Comparison of online BIO105 2008 to 2010

Group Comparison	***Difference Between Means***	***95% Confidence Limits***		
Biol105_2008 - Biol105_2009	0.44	0.07	0.81	Significant
Biol105_2009 - Biol105_2010	0.37	-0.05	0.81	Not significant
Biol105_2008 - Biol105_2010	0.82	0.37	1.26	Significant

Table 6: Pairwise Comparison of online ENGL 111 2008 to 2010

Group Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
Engl111_2008 - Engl111_2009	0.23	-0.22	0.68	Not significant
Engl111_2009 - Engl111_2010	0.17	-0.31	0.654	Not significant
Engl111_2008 - Engl111_2010	0.40	0.01	0.79	Significant

Figure 4: BIOL 105 Campus-based versus online percentage passing and failing rates

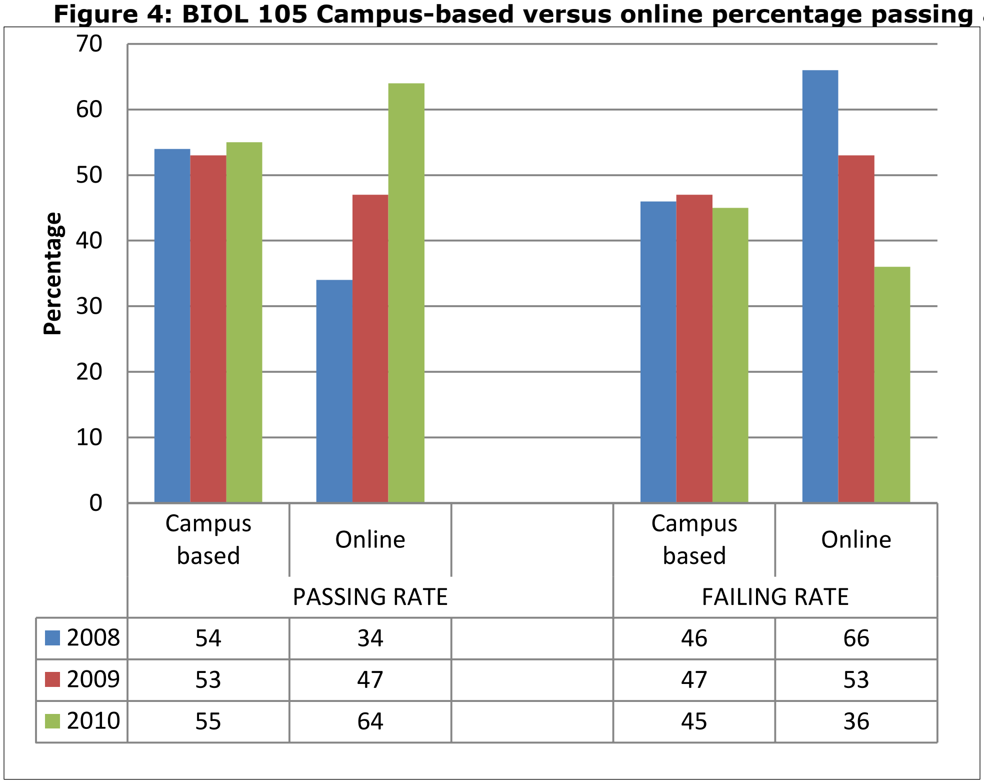
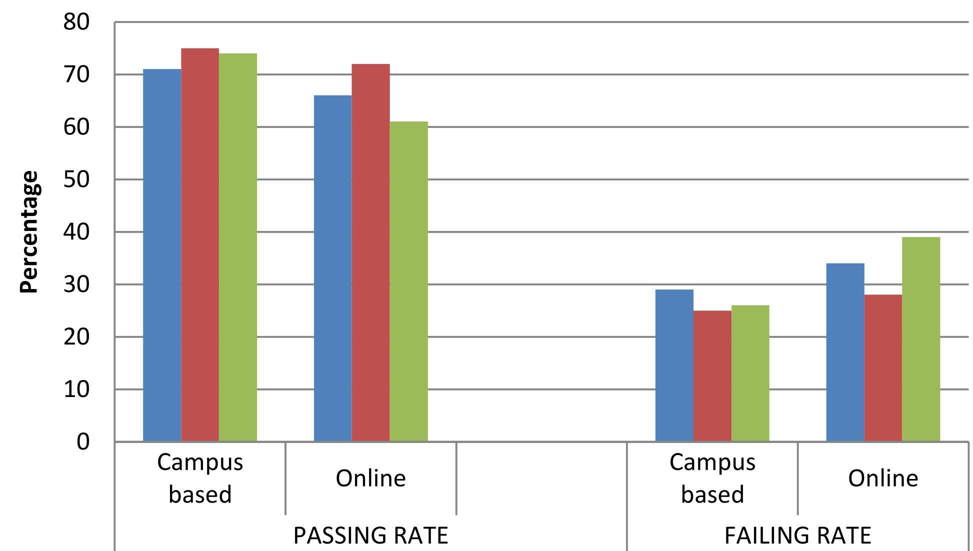
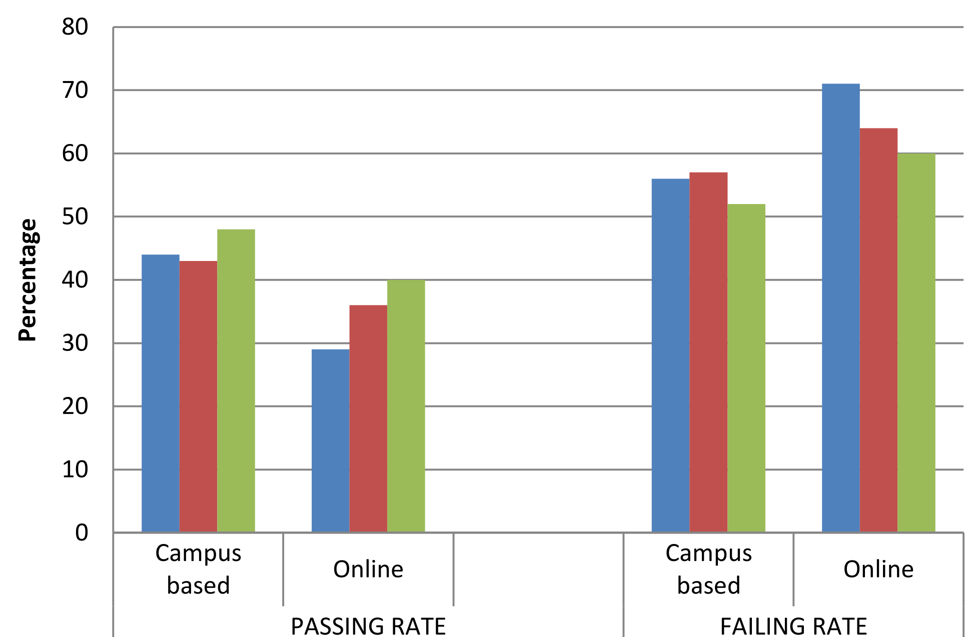


Figure 5: COMM 210 Campus-based versus online percentage passing and failing rates



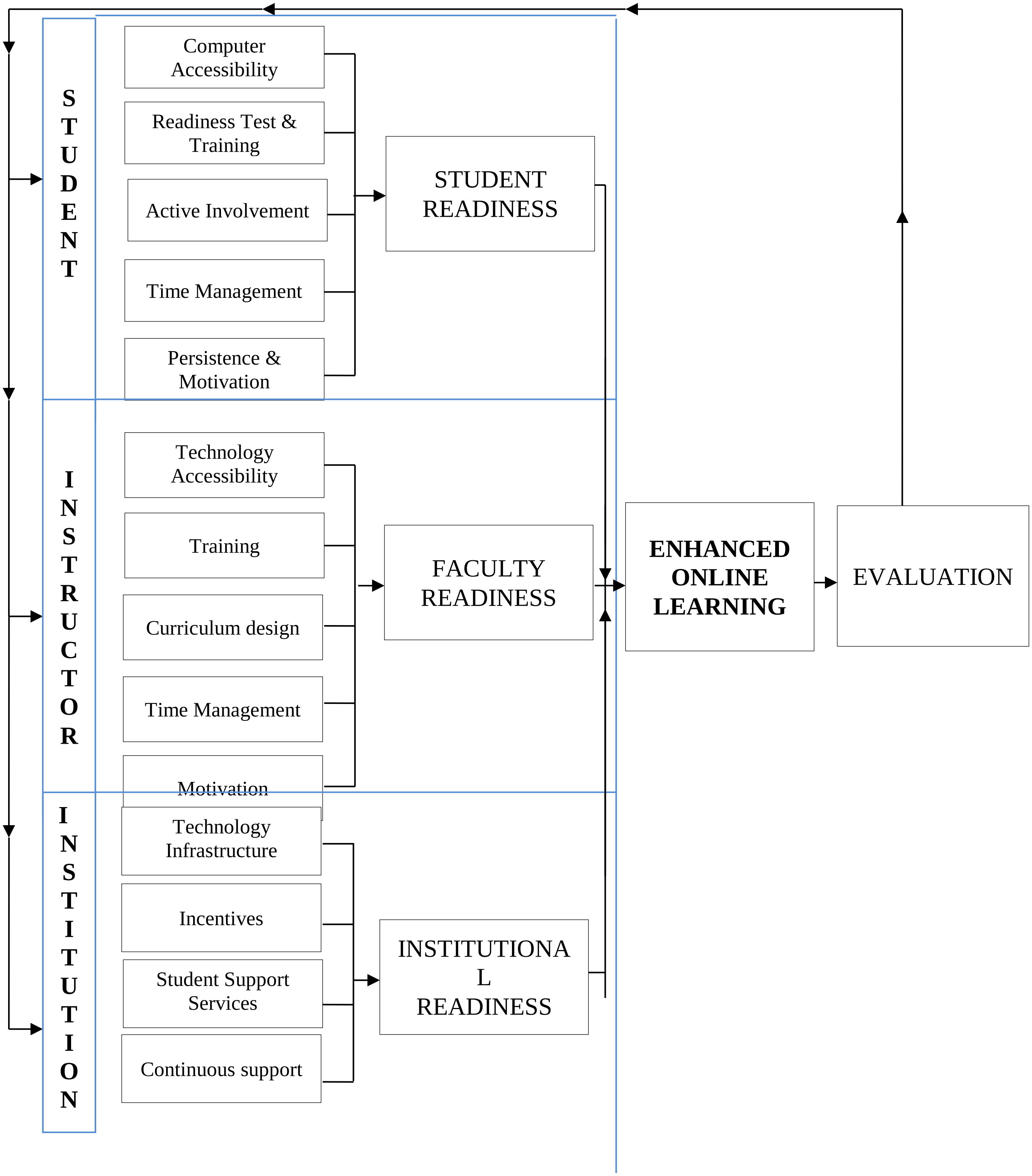
	PASSING RATE Campus based	PASSING RATE Online		FAILING RATE Campus based	FAILING RATE Online
2008	71	66		29	34
2009	75	72		25	28
2010	74	61		26	39

Figure 6: ENGL 111 Campus-based versus online percentage passing and failing rates



	PASSING RATE Campus based	PASSING RATE Online		FAILING RATE Campus based	FAILING RATE Online
2008	44	29		56	71
2009	43	36		57	64
2010	48	40		52	60

Figure 7: Model for Enhancing Online Learning



Information Technology for Good (IT4G): Merging Information Technology with Social Responsibility

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Abstract

A case is made for a new approach to higher education in the 21st century, an approach in which the traditional majors are extended beyond their usual boundaries by applying one's education to address the public good. The LEAP initiative and the Learning Paradigm College are advanced as exemplars of effective 21st century educational practices, and it is shown that these two concepts are consistent with both employer expectations of college/university graduates and the expectations of both school and program accrediting agencies. The Information Technology for Good (IT4G) initiative is advanced as an exemplar of using Information Systems/Technology education to advance the public good. Examples of IT4G in action are presented, and an invitation is extended to other information systems academic programs to join the Computer Information Systems program at Quinnipiac University in this endeavor.

Keywords: Information Technology for Good (IT4G), Essential Learning Outcomes (ELO's), Liberal Education and America's Promise (LEAP), Learning Paradigm, Program Educational Objectives (PEO's).

1. HIGHER EDUCATION IN THE 21st CENTURY

Today's world is being dramatically reshaped by a number of forces; scientific and technological innovations, global interdependence, cross cultural encounters, and changes in the balance of economic and political power are all changing the context in which today's students will make choices and compose lives. The speed and magnitude of these changes is ever increasing thereby creating a volatile context of disruption rather than certainty, and of interdependence rather than insularity. This volatility also applies to careers. According to a recent study by the Bureau of Labor Statistics (2010), most Americans change jobs at least ten times in the two decades after they turn eighteen, with such changes even more frequent for younger workers.

Given these developments, and informed by both evolving professional standards and the views of employers, a consensus is emerging among educators and professionals about what types of learning Americans need from college. Almost all agree that there is a need to "practice what we teach"; i.e., to move education from a "behind the scenes" analysis of the world to an education that involves actively applying the principles studied by addressing public priorities (Sullivan, 2008).

What Matters in College? College and university students already know that they want a degree. The challenge is to help students become self-directed learners who are much more intentional about the forms of learning and the accomplishments that their degree should represent. The National Leadership Council for

Liberal Education and America's Promise (LEAP) (2007) calls on American society to give new priority to a set of educational outcomes that all students need from higher learning, outcomes that are closely calibrated with the challenges of living and working in an increasingly complex and volatile world. Keyed to work, life, and citizenship, LEAP's Essential Learning Outcomes (ELO's) (2007) are important for all students and should be fostered and developed both (1) across the students' entire educational experience, and (2) in the context of students' major fields of study. The ELO's provide a framework to guide students' cumulative progress—as well as curricular alignment—from high school through their entire undergraduate college education. The LEAP initiative does not call for a "one-size-fits-all" curriculum. Rather, it recommends that the ELO's can and should be achieved through many different programs of study and in all types of collegiate institutions, including universities, colleges, community colleges and technical institutes, both public and private.

The LEAP initiative recommends an education that intentionally fosters a wide range of knowledge of science, cultures, and society; high-level intellectual and practical skills; an active commitment to personal and social responsibility; and the demonstrated ability to apply learning to complex problems and challenges. It calls on educators to help students become "intentional learners" who focus on achieving the ELO's no matter what their chosen field of study. But to help students do this, educational communities will have to become far more intentional themselves—both about the kinds of learning students need, and about effective educational practices that help students learn to integrate and apply their learning.

The diversity that characterizes American higher education remains a source of vitality and strength. Yet all educational institutions and all fields of study also share in a common obligation to prepare their graduates as fully as possible for the real-world demands of work, citizenship, and life in a complex and rapidly changing society. Highlighting these shared responsibilities, LEAP (2007) urges the adoption of a new compact between educators and American society to both implement and achieve new Principles of Excellence. Informed by scholarly research on effective practices in teaching, learning, and curriculum (Kuh 2007, 2010), the Principles of Excellence offer both challenging standards and flexible guidance for an era of educational reform and renewal. These principles underscore the need to teach students how to integrate and apply their learning across multiple levels of schooling and across disparate fields of study and call for a far-reaching shift in the focus of schooling from accumulating course credits to building real-world capabilities.

2. THE QUINNIPIAC UNIVERSITY LEARNING PARADIGM

Quinnipiac University is in the midst of an institutional transformation that will benefit every member of our community. The transformation involves our commitment to continuous improvement and our ongoing development as a learning paradigm institution (Tagg, 2003). In this paradigm, learning, as opposed to instruction, is central to the mission of the University. In this context each member of the community fully accepts responsibility for student learning; everyone's effort and all institutional decisions support learning as the primary goal. It means our effectiveness is measured on student learning outcomes rather than inputs or instructional processes.

Our transformation to a learning paradigm exemplar is grounded in the adoption of the Essential Learning Outcomes (ELO's). Preparing our students to meet these employer expectations requires the adoption of High Impact Practices (Kuh, 2008; Brownell 2010)) to provide them with the ELO's for the 21st century. While no one department is responsible for providing their students/majors with all of the ELO's, the curriculum when taken as a whole should insure that each student is provided with the complete educational experience.

Essential to the adoption of the ELO's is the commitment to provide each student with an education in *Personal and Social Responsibility* anchored through active involvement with diverse communities and real-world challenges. At Quinnipiac University this has been interpreted to mean that beginning as early as the university admissions process, and continuing at successively higher levels across their college studies, students should prepare for twenty-first-century challenges by obtaining civic knowledge and engagement at the local and global levels, intercultural knowledge and competence, ethical reasoning and action, and foundational skills for lifelong learning. Indeed, as Thompson (2011) eloquently points out:

- In a democracy that is diverse, globally engaged, and dependent on citizen responsibility, all students need an informed concern for the larger good because nothing less will renew our fractured and diminished commons;
- In a world of daunting complexity, all students need practice in integrating and applying their learning to challenging questions and real-world problems;
- In a period of relentless change, all students need the kind of education that leads them to ask not just "how do we get this done?" but also "what is most worth doing?"

With organizations constantly reinventing their products and their processes, and with questions about public and life choices more complex than ever, the world itself is setting higher expectations for knowledge and skill. The Essential Learning Outcomes respond to this reality.

3. EXPECTATIONS OF EMPLOYERS

Integral to the task of justifying the transition to a Learning Paradigm institution and the adoption of the Essential Learning Outcomes is verifying that the ELO's are consistent with expectations of the employers of our graduates. Zinn (2010), employing market demand data for the ELO's from the U.S. Department of Labor's *O*Net Online* database (http://www.onetonline.org/), verified that that the ELO's are exactly what they claim to be—"important skills valued by employers." Zinn's study further verified that each of the ELO's is relevant to every one of the distinct 854 occupations identified by the U.S. Department of Labor.

The *O*NET database* (National Center for O*NET Development, 2011) is perhaps the most comprehensive and authoritative source available on occupational requirements. Since many employers use the O*NET occupational requirements data in crafting job descriptions and evaluating work performance, the occupation-specific market demand data for the ELO's can significantly contribute to student success by clarifying exactly what knowledge and skills students need to know/possess and market to employers in order to compete for highly competitive jobs and advance in their careers. The ELO's are indeed "essential" as they capture and combine what among the multitude of potential occupational requirements identified by the U.S. Department of Labor appear to be not only in demand for every occupation, but also the most prominent requirements for 21st century occupations, particularly those requiring a Bachelor's degree or more. As Zinn points out, "The O*NET data also contains for every occupation an assessment of the strength of market demand for each ELO. That is, since each O*NET descriptor is ranked according to one or more dimensions (e.g.; importance, achievement level), it is possible to know for each occupation how "important" each outcome is for the given occupation, as well as the "level" of achievement in that outcome that is necessary for the given occupation."

With this information illustrating the ELO's specific to particular occupations, students can see more clearly the relevance of the ELO's to career preparation in general (through the corresponding transferable detailed work activities), as well as to their occupations of interest (through the corresponding occupation-specific tasks). Additionally, students can gain detailed meaningful insight on both (1) occupation-specific and transferable experiences and (2) meaningful artifacts gained through internships and other professional projects (e.g. research and selected classroom and co-curricular activities) that they can use to demonstrate possession of the ELO's. Thus, a course of study grounded in the ELO's, being both geared towards specific occupations and applicable to a wide set of entry-level and advanced occupations, is simultaneously tailored to students' immediate specific career interests as well as solid preparation for long-term employment in a changing economy where occupational flexibility is vital for career success.

4. CORPORATE SOCIAL RESPONSIBILITY

Gone are the days when a company's "bottom line" consisted solely of its fiscal achievements. Today, large and small businesses alike are more focused on a triple-bottom-line of people, planet, and profit (Colby, Ehrlich, Beaumont, Stephens, 2010). Increasingly, organizations are looking to the post-secondary educational sector to supply the next generation of business leaders to help them make this change. As such, colleges and universities are feeling external pressure from the business community to shift their course offerings and student extracurricular activities accordingly (Sullivan & Rosen, 2008).

The term *Corporate Social Responsibility* (CSR) encompasses activities that a business voluntarily adopts in order to minimize possible negative impacts of its operations on the environment or other human beings. CSR integrates the tenants of social responsibility into the corporation's business model; the adoption of CSR thus functions as a self-regulating mechanism through which a business continuously monitors its active compliance with the spirit of the law, ethical standards, and international norms. The goal of CSR is to embrace responsibility for the company's actions and encourage through its activities a positive impact on the environment, consumers, employees, communities, direct stakeholders and all other members of the public who may also be considered as stakeholders.

There is no clear-cut definition of what CSR comprises. While individual companies may have different operational CSR objectives, their main motives are the same as the stake holders of every company are increasingly taking an interest in how the activities of the company are impacting both the environment and society. Many critics of CSR (Friedman, 1970; Sullivan & Schiafo, 2005) argue that CSR distracts from the fundamental economic role of businesses; others argue that it is nothing more than superficial window-dressing; others argue that it is an attempt to pre-empt the role of governments as a watchdog over powerful corporations. But there is no systematic research evidence to support any of these criticisms. A significant number of studies (e.g.; Fields, 2002; Roux, 2007) have shown no negative influence on shareholder results from CSR, but rather a slightly positive correlation with improved shareholder returns. Indeed, even beyond the intrinsic value of educating students in this type of self-regulation, the adoption of CSR by businesses can have a major impact on corporate recruitment, retention, and ultimately, revenue. Indeed, it has been posited that socially responsible organizations make more money that those that do not actively engage CSR as a corporate value.

5. CSR IN BUSINESS AND INFORMATION SYSTEMS ACCREDITATION

Consistent with the LEAP initiative and the expectations of employers of our graduates, Quinnipiac University has adopted the ELO's as university-wide student outcomes, and has consequently committed to providing every graduate of the university with an education in *Personal and Social Responsibility* anchored through active involvement with diverse communities and real-world challenges.

The Associate to Advance Collegiate Schools of Business (AACSB) (AACSB International, 2011) expects that we will adopt business school learning outcomes that are both consistent with institutional mission and demonstrable to our various publics. Thus, demonstrable attention to personal and social responsibility at the corporate level is fundamental to our business school maintenance of accreditation. While most business schools address this issue at the graduate level, we do so at the undergraduate level through the inclusion of both *SB 211 Ethics and Diversity* and *SB 450 Strategic Management Seminar* as core requirements for all of our business school students.

We are an Information Systems program that is accredited by the Computing Accreditation Commission (CAC) of ABET, Inc. (ABET, 2011) located within an AACSB accredited School of Business. We have formally adopted the IS 2010 Model Curriculum standards (Topi, Valacich, Wright, Kaiser, Nunamaker, Sipior, & Vreede, 2010), and subscribe to the ABET-accreditation criteria. We have formally adopted ten (10) student learning outcomes (LO's) in support of our PEO's, two of which relate directly to the tenants of Corporate Social Responsibility: (1) an understanding of professional, ethical, legal, and security issues and responsibilities, and (2) an ability to analyze the local and global impact of computing on individuals, organizations, and societies.

The CIS department does not have a separate social responsibility course, but we do treat the issue of social responsibility as part of our "understanding of professional, ethical, legal, security and social issues and responsibilities" student learning outcome in many of our courses. The problem was how to effectively reinforce the tenants taught in both SB 211 and SB 450 and also addressed in many CIS courses; i.e., how to make the issues come alive for both students by directly/actively exposing them to CSR tenants in action. For just like raising a child, students learn not what we say, but what we do. The solution: in the spring of 2011 we formally adopted the *Information Technology for Good* (IT4G) initiative.

6. THE INFORMATION TECHNOLOGY FOR GOOD (IT4G) INITIATIVE

Today's economic reality has brought about a renewed focus on helping others, and the academic arena is following suit by linking individual education with the ability to affect the greater good. In this spirit, information technology and social responsibility are merging together at Quinnipiac University's Department of Computer Information Systems (CIS) in an effort called *Information Technology for Good* (IT4G). Inspired initially by the Georgia Tech College of Computing's *Computing for Good* (C4G) course (Zagura, 2011) which has been offered as a capstone for Georgia Tech's undergraduate Computer Science majors each fall semester since 2007, Quinnipiac University's IT4G initiative is much more than a single course; rather it is a significant driver for student course projects, faculty research, and student club activities.

In the field, computing has the ability to advance the human condition. In the classroom, IT4G has the ability to enhance the learning experiences and enrich the lives of tomorrow's technology leaders. IT4G goes well beyond a single classroom; rather, it is an emerging value system for the department around which student projects, faculty research, and student club activities have coalesced. We would like all faculty and all students to consider the power they have as seasoned or emerging information systems professionals to make positive changes in the lives of people who struggle to help themselves.

Technology has been changing the world at a rapid pace for decades, and now a major promise of computer information systems is to improve the human condition and facilitate the progress of communities and the advancement of societies. IT4G centers on the concept of applying information technology to social causes and improving the quality of life. Indeed, one person or group of people can make a difference. IT4G draws on the altruistic side of both students and faculty by presenting CIS as a cutting-edge discipline that empowers them to solve problems of personal interest as well as problems important to society at large.

Computer Information Systems are becoming increasingly global, human-centered and focused on solving problems. IT4G combines all those elements and allows students to work for causes they really care about. The faculty and students of the department feel that IT4G has the potential to both reinvigorate the discipline as it emerges from a decade long enrollment slump and attract a new generation of students to the field. Many of today's incoming college students don't really know what computer professionals actually do, or how a degree in computer information systems will help them. IT4G paints a powerful picture for these students. They may arrive without a background in information systems, but when they see the positive impact they can have by applying information systems to social problems they are suddenly able to picture themselves majoring in computer information systems.

Current students also can benefit from approaching their work in the context of using information systems to promote social change. When students create practical solutions for socially relevant problems, they feel more enthusiastic about and committed to their work because they can actually see the impact of what they are doing. They become socially active citizens of the world through the application of computer information systems.

7. IT4G IN ACTION

The IT4G impact at Quinnipiac University has been immediate and real. Faculty and students throughout the department have/continue to work on class projects, research, and extracurricular activities that have positively impacted the lives of others. For example:

Curriculum:

- Our *Introduction to Information Systems* course is based on developing mobile apps to solve problems that are of real interest to the students. While admittedly a bit self-focused, many of the student developed applications do address social issues both on campus and in the immediately surrounding community;
- Our *Systems Analysis and Design* class is project based, focusing on developing real

solutions to problems/issues faced by local not-for-profit corporations;

- Professor Ceccucci has traveled and continues to travel with groups of M.B.A. students to Nicaragua and Professor McCarthy has traveled and continues to travel with groups of M.B.A. students to China to provide business computing consulting expertise to developing rural economies.

Research and Faculty Development:

- Professor Subramanian serves as a visiting faculty fellow at the Yale Law School Information Society Project, an intellectual center addressing the implications of the Internet and new information technologies for law and society, guided by the values of democracy, human development, and social justice;
- Professor Subramanian also spent a year as a Fulbright Senior Researcher at the Indian Institute of Technology in Madras, India focusing on the development of telecommunications and wireless technologies in developing rural economies;
- Professor Saulnier, along with colleagues from three other universities, published a paper which addressed how the use of "green technology" might be integrated into the undergraduate information systems curriculum.

Extracurricular Activities:

- The CIS Society (our student club) recently ran a Facebook for Seniors project in which club members traveled to a local senior center to teach senior citizens how to use both Skype and Facebook to more effectively communicate with their families via social media;
- The CIS Society is offering and managing a free peer tutoring program for CIS majors and minors in which students who have successfully completed major courses with outstanding grades make themselves available to other students currently taking those courses;
- The CIS faculty have adopted the use of iPads and have placed all course documents in the university's Blackboard course management system, in part to promote the decreased use of paper products consistent with Quinnipiac University's focus on sustainability;
- Our IT4G initiative is still early in its development, but both students and faculty feel a renewed sense of direction as they see first-hand the results of using their CIS skills to substantively contribute to the well-being of others.

8. CONCLUSIONS/RECOMMENDATIONS

Following a somewhat slow start, the IT4G initiative is gaining momentum and is being enthusiastically embraced by faculty and students alike. Substantive direct benefits resulting from the adoption of the initiative include:

- The IT4G initiative has assisted in moving students perceptions of CIS as a major for "geeks", an image that has been reinforced by popular culture (e.g.; "Geeks to Go", movies, television commercials) to a cutting-edge discipline leading to high demand and lucrative career employment options that can substantively contribute to society; as such,
- The IT4G initiative has assisted in raising the number of CIS majors as the number of previously undeclared students who have declared CIS as their major has doubled compared to the prior year; and,
- The IT4G initiative has reinforced a more business professional perception of the department among both faculty and students of other departments, both in the school of business and across campus.

We are most pleased to extend an invitation to other academic IT, IS and CIS departments across the country to join us in working together to use IT to improve the common good. Who knows; it's even possible that we could start a national movement as we broaden our professional responsibilities as information systems educators and business professionals to use our discipline and skills to improve the common good.

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Building a Cybersecurity Workforce with Remote Labs

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Abstract

Now more than ever, cybersecurity professionals are in demand and the trend is not expected to change anytime soon. Currently, only a small number of educational programs are funded and equipped to educate cybersecurity professionals and those few programs cannot train a workforce of thousands in a relatively short period of time. Moreover, not only are additional educational resources needed, but the programs need to deliver high quality, hands-on learning for future cybersecurity professionals. Survey results show that lack of funding and lack of equipment prevent some educational institutions from providing a hands-on learning component in security curricula. One solution is the use of remote labs to increase the number of students with access to security lab environments. We propose that it is an appropriate time for Centers of Academic Excellence in Information Assurance and other organizations to collaborate to assist universities, community colleges and even high schools, through the development of remote security labs, to increase our nation's capacity to adequately train a large number of cybersecurity professionals. The authors have recently implemented a remote lab infrastructure to begin testing the viability of the concept on a small scale.

Keywords: cybersecurity, remote lab, hands-on learning, curriculum

1. INTRODUCTION

I hear and I forget
I see and I remember
I do and I understand
Chinese Proverb

Cybersecurity is a serious challenge to all organizations, but especially to governments. The urgency of confronting the challenge increases daily, even exponentially with recent discovery of the Stuxnet worm. The concern was addressed at the federal level in 2009 when our national cybersecurity strategy was updated to include 12 key initiatives. Of key interest to information systems academicians is Initiative #8 of The Comprehensive National Cybersecurity Initiative (CNCI) (National Security Council, 2009) which is the directive to expand cyber education. The need is outlined in the CNCI as follows "…there are not enough cybersecurity experts within the Federal Government or private sector to implement the CNCI, nor is there an adequately established Federal cybersecurity career field" (p. 4). This urgent need is echoed in the Bureau of Labor

Statistics' Occupational Outlook Handbook. The BLS projects that jobs for network and computer systems administrators will increase by nearly 79,000 from 2008 to 2018. While not all new jobs in this area will require a specialty in security, the BLS notes that "[a]s cyber attacks become more sophisticated; demand will increase for workers with security skills" (U.S. Department of Labor, Bureau of Labor Statistics, 2010-2011). The BLS does not yet identify cybersecurity as a separate job title. However, the National Initiative for Cybersecurity Education (NICE) is addressing this absence of a common language to discuss the work and skill requirements of cybersecurity professionals (National Initiave for Cybersecurity Education, 2011). This absence hinders the ability to identify skill gaps in the security workforce. Nevertheless, it is widely accepted the need for cybersecurity professionals is great and the trend is expected to continue. For example, within the government sector, the Department of Homeland Security alone is expected to hire up to 1,000 cybersecurity professionals over the next three years ("Cyber help wanted," 2009).

The CNCI also expresses concern about the current ability to train cybersecurity personnel: "Existing cybersecurity training and personnel development programs, while good, are limited in focus and lack unity of effort. In order to effectively ensure our continued technical advantage and future cybersecurity, we must develop a technologically-skilled and cyber-savvy workforce and an effective pipeline of future employees. It will take a national strategy, similar to the effort to upgrade science and mathematics education in the 1950's, to meet this challenge" (p. 4).

Currently, the U.S. may not be in a position to quickly and adequately train the sizeable cybersecurity workforce needed (Locasto, Ghosh, Jajodia, & Stavrou, 2011). A crucial element of the security professional's job is the ability to analyze and understand a variety of risks and then to evaluate appropriate preventative or responsive measures. Therefore, not only do we need large numbers of cybersecurity professionals, we need them trained in an environment where they can practice these important skills. As Locasto and colleagues (2011) point out, only a small number of educational programs are currently funded and equipped to educate cybersecurity professionals and those few programs cannot train a workforce of thousands in a relatively short period of time. Moreover, not only are additional educational resources needed, but the programs need to deliver high quality, hands-on learning for future cybersecurity professionals.
In this paper, we report on survey results that align with the concern that the U.S. may not be adequately equipped to train large numbers of cybersecurity professionals. In response to the findings, we then suggest a coordinated effort to aid in such training, namely through remote labs. The rest of the paper is laid out as follows: next is a brief literature review supporting hands-on learning; then the findings of the survey are presented as the current state of security curricula; then a brief rationale for a remote lab solution is offered; and finally other considerations and a conclusion are presented.

2. HANDS-ON LEARNING

The traditional method of university learning is through reading (or summarizing) a textbook and doing problems or examples through rote memory of either formula or fact. Hands-on experiences are often used only to verify the facts stated in the textbook (Bork, 2000). In today's environment, educators in all areas of information technology are being challenged to move beyond traditional methods of instruction (i.e. the lecture mode) to an approach that calls for an increased interactivity with students about both the subject content and learning strategies (Bork, 2000). Many educators stress the importance of active learning (Boggs, 1999; Bonwell & Sutherland, 1996; Conklin, 2006; Felder & Brent, 2003), even dating back to Dewey's "genuine education" (Dewey, 1938). It is well accepted among most faculty that a hands-on approach to learning is the preferred method.

Specific to cybersecurity, an integral piece of any training is the opportunity to work in an interactive hands-on environment. Problem solving skills are best developed in this fashion. The incorporation of real world problems needs to include challenges that rise above simplistic scenarios. Instead, these problems need to propel students into the realms of higher order critical thinking skills: analysis, synthesis and evaluation (Bloom, 1956) such as are required in the cybersecurity professional's daily job. Students must be able to practice "professional artistry" (Schön, 1987) in order to prepare for today's cybersecurity career. Problems faced in the daily duties require the professional to look at security issues from both the attack and defend perspectives, and to adapt to ever changing threats. Therefore, a hands-on curriculum is likely to produce the most effective results in training cybersecurity professionals. Building upon the theoretical foundation that supports not only collaborative, but also active or hands-on learning, we had the opportunity to redesign our own security curriculum in 2006. All courses in the curriculum hence consist of lecture and lab, with an emphasis on hands-on experience (Woodward & Young, 2007). Outcomes were measured as positive when students placed first of seven teams in their first Regional Collegiate Cyber Defense Competition. Graduates of this curriculum are highly recruited into a variety of information security jobs, and the university is a National Center of Academic Excellence in Information Assurance Education (CAE/IAE).

As a step toward building a national cybersecurity workforce, now is an appropriate time for CAEs to collaborate at a higher level to address the challenge. Given our experience and the experience and capabilities of other CAEs, a suitable approach would be to assist other universities, community colleges and even high schools to “build educational capacity” as first suggested by Locasto and colleagues (Locasto et al., 2011).

Before proceeding however, it is important to consider the current state of cybersecurity curricula.

3. STATE OF CYBERSECURITY HANDS-ON CURRICULUM

Supported by educational theory, we believe that the hands-on component in the security curriculum is the key to student success. Several courses commonly comprise a security curriculum including topics in security awareness, information assurance, network security, forensics, wireless security, and generally, a capstone course. Interestingly, some U.S. educational institutions offer security related courses without a hands-on component.

To better understand the state of security curricula, the authors collected data from a survey administered to security instructors over a six year period, ending in 2011. The survey was distributed to attendees of The Center for Systems Security and Information Assurance Train-the-Trainer courses at a Midwestern location. One hundred thirty-nine instructors responded to survey questions regarding their respective security curricula. The respondents represented 32 universities, 85 community colleges, 8 vocational/technical schools, and 14 high schools. Providing specific demographic data was optional, but at least 20 states were represented from Hawaii to New York and Florida.

Table 1 displays the statistics of greatest concern from the survey: courses offered without a hands-on lab component. The N for universities and community colleges are smaller due to missing responses.

Table 1. Percentage of organizations NOT offering a hands-on component.

N	25	73	8	14
	University	Comm College	Voc/Tech	High School
Sec Awareness	55%	16%	20%	43%
IA I	30%	13%	40%	80%
IA II	56%	23%	60%	100%
Net Sec I	21%	9%	0%	14%
Net Sec II	50%	21%	50%	50%
Forensics I	33%	32%	60%	83%
Forensics II	62%	49%	60%	100%
Wireless Sec	55%	28%	43%	33%
Capstone	50%	31%	60%	57%

Included in the 139 respondents were a number of schools that are designated Centers of Academic Excellence or were in the process of becoming a CAE. The breakdown is displayed in Table 2. Two year colleges are eligible to receive the CAE2Y designation.

Table 2. Number of CAEs by organization type.

	N	CAE	In Progress	% of total
University	32	11	2	40.6%
Comm College	85	10	2	14.1%
Voc/Tech	8	1	0	12.5%

Community college CAEs and the single Vocational/Technical School CAE reported hands-on lab components for all security courses. However, surprisingly, survey results indicated that a number of university level CAEs did not offer hands-on lab components to some courses as shown in Figure 1. Depending on the course, the percentage of university CAEs not offering hands-on components ranged from 33% (Network Security I) to 80% (Forensics II).

For all educational institutions, when asked what barriers prevented the provision of hands-on lab components to the curriculum, lack of funding topped the list. Respondents were allowed to check as many as applied. All barriers are shown in the Table 3.

Figure 1. Percentage of university CAEs NOT offering a hands-on component.

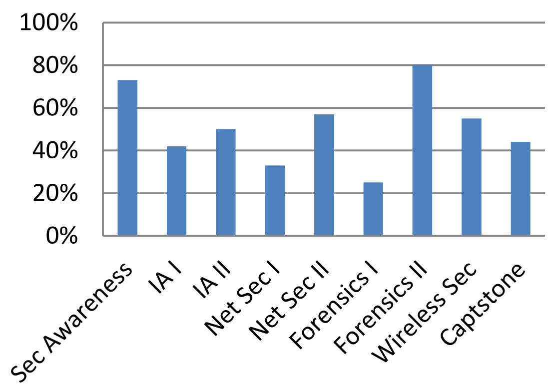

Table 3. Frequency of barriers to providing labs

Barrier	Frequency
Lack of funding	79
Lack of equipment	65
Lack of instructor training	49
Lack of space for equipment	34
Lack of tech support	34
Perceived security vulnerabilities by IT staff	32
Lack of space for student access	27
Lack of training for maintaining equipment	27
Perceived security vulnerabilities by admin	20
Other barriers	20
No barriers	9

The top two barriers, lack of funding and equipment, come as no surprise. In times of economic hardship, education funding is usually at the top of the list for cuts, and it becomes extremely difficult, if not impossible, to secure money for new programs, faculty, and lab equipment. The next three barriers, lack of instructor training, lack of space, and lack of technical support, can also be traced back to funding. Qualified instructors could be hired or current instructors could attend train-the-trainer workshops if funding was available. Space required for equipment and labs could be constructed if training cybersecurity professionals was deemed an urgent need. Likewise, technical support staff could be added or contracted with adequate funding.

The results provide some insight into the issue, but regardless of the reasons, the considerable lack of hand-on training in security curricula, even in some that are designated CAEs, is cause for concern. Considering the growing demand for skilled cybersecurity professionals, we must find ways to get hands-on skills to a large number of individuals, and to do it rather quickly. To that end, we support Locasto et al.'s (2011) suggestion that a collaborative effort among universities, community colleges and high schools is necessary and we argue that the need is urgent.

4. REMOTE LABS AS A SOLUTION

One avenue of collaboration is to offer remote lab access to enrich existing security curricula or to enable security courses to be offered with a lab component even at the high school level. Like traditional labs, remote labs utilize equipment and space, however, the equipment is accessed through a geographically distant computer. However, users are accessing a physical network environment. Remote labs are not to be confused with simulators which provide an emulation of the network environment. Simulators do not always process unexpected or incorrect commands appropriately leaving the user without important information that would have been provided in a physical network environment. Therefore, a simulation does not offer the ability to develop "professional artistry" like a remote lab.

Remote labs offer a number of other advantages as well. Lack of financial resources and equipment top the list of barriers to hands-on labs, but remote labs could be housed in CAEs and funded to provide access to other universities, community colleges, and high schools. Although a degree of funding is required, it would be far less expensive to outfit a number of CAE hubs than to support dozens or hundreds of separate institutions.

Other barriers such as lack of training and lack of support would also be addressed by remote labs. Training for instructors could be accommodated in the remote lab environment and the technical support would be provided by the CAE hub. On-site workshops and courses could also be provided to other types of organizations such as in the private sector.

Remote labs also afford the opportunity to work in a team environment. Through proper lab settings, students can work on the same network environment simultaneously as part of a team. Additionally, remote labs remove the time and space limitations of traditional labs, thereby allowing more users overall to share the resources. Virtualization software can also help ease the burden of single use network equipment and has been shown to be a viable solution (Wu, 2010).

Not only is the infrastructure barrier addressable with a remote lab environment, but the lab content could be provided as well. The National Security Agency funded SEED project has produced a number of security education labs as well as support material for instructors (Du, 2011). This project could easily be incorporated into a larger remote lab project.

We need a large cybersecurity workforce, and we need one that is hands-on trained in the latest tools and techniques of the field. In the short term, rather than reinventing the wheel in educational organizations across the nation, we should utilize our CAEs to become the hubs of cybersecurity education and training, connecting not only with other educational institutions, but with industry partners as well. Services offered through the CAE hubs could include train-the-trainer workshops, remote access labs, lab content, and even hosting of security colloquia.

The authors recently received local funding to purchase remote lab software and hardware in order to enhance and expand the course offerings within the department and across other campus courses that employ hands-on labs based on desktop computing resources. The technology allows for students to remotely access a wide range of hardware and software resources for use in conjunction with security and networking courses. The technology provides students anywhere, anytime access to lab resources via a standard web browser. Security concerns are also reduced for the host due to the web browser interface. It also provides very powerful and flexible management capabilities for instructors and access to a plethora of industry validated training, learning materials and activities. This is specifically the type of remote lab environment that can be expanded to partner universities, community colleges and even high schools that are burdened by the barriers mentioned in this study.

5. OTHER CONSIDERATIONS

Pushing cybersecurity training down to the high school level is also an important endeavor. Recruiting students into science, technology, engineering and mathematics (STEM) remains a high priority for the U.S. Today's students have grown up in the media age, and little attention to what that means in terms of lifestyle has been introduced into public school curricula. For example, issues such as the need to focus on personal privacy and avoidance of intellectual property violations should be standard discourse in public schools. There is great need to initiate these conversations at an early age, and to expose students to the idea of cybersecurity. Providing workshops and hands-on lab access could aid in that type of training. Barring full scale cybersecurity curricula or courses in high schools, even offering workshops or in-class demonstrations could fuel interest in the STEM fields, and particularly in cybersecurity. These platforms could serve as recruiting tools for all students, including minorities, and women to fulfill skill needs of the future workforce. Recruiting more students into computing and technology disciplines will likely result in more students choosing cybersecurity as a profession.

In the longer term, standard curricula should be embraced by universities, community colleges, and even high schools. The ITiCSE Information Assurance Curriculum Guidelines Working Group has published preliminary guidelines for security curriculum (Cooper et al., 2010). The final document is expected to be published as IA2013. The guide will provide knowledge areas and specific subjects that are recommended for a security curriculum. While the guide does not specifically address hands-on learning in the body of knowledge, the authors certainly recognize its value: "[the] working group considers such practical hands-on training as important means that can be used to reach the learning goals…" (Cooper et al., 2010).

6. CONCLUSION

U.S. organizations, both government and private, need a massive, well-trained cybersecurity workforce sooner rather than later. The infrastructure to train small numbers is there. Funding remote labs to expand capacity is a timely idea that could address the demand relatively quickly and economically. It is through the remote lab environment that students will gain the hands-on experience component deemed vital by educational theorists. This will lead to effective education and training which enables our country to build the specialized workforce with the right skills, at the right time and place to protect our citizens and assets. Although the use of remote labs is not a new idea, the authors have now put the infrastructure in place to test the viability of the solution. The next step is to analyze the opportunities now available through our own remote lab software. Effort is underway to plan an initial slate of offerings across our campus and with partner schools. Future research will follow the progress of these efforts.

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A Database Management Assessment Instrument

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Abstract

This paper describes an instrument designed for assessing learning outcomes in data management. In addition to assessment of student learning and ABET outcomes, we have also found the instrument to be effective for determining database placement of incoming information systems (IS) graduate students. Each of these three uses is discussed in this paper. We describe the use of a pre/post test, item validation, and correlation techniques for the purpose of validation and assessment. Although the instrument was developed for local assessment, its design is based on international information systems curriculum guidelines rendering it suitable for use in any program which incorporates database management in its curriculum.

Keywords: assessment, database, data management, exams, outcomes

1. INTRODUCTION

Universities are increasingly being required to demonstrate that student learning is occurring at their institutions in measurable, documented ways, and that these measurable results are being used to improve their educational programs. Assessment of learning has become a requirement of institutional and program accreditation. Many methods of assessment are possible, including internally/externally developed, direct/indirect measures of performance, and formative/summative indicators. Often these assessment approaches are developed for "local" use, i.e. they are not designed to be generalized for use by similar programs at peer institutions. This paper describes the development, validation, use, and results interpretation of a database exam—an internally-developed, direct assessment, formative indicator of student learning in a four-year information systems (IS) degree program—that we believe can be used for assessment in any program requiring a database management course. In the sections that follow, we describe the foundation for the exam, the approach taken for developing and verifying exam items, the approach taken for validating that the exam is a useful instrument for student outcomes assessment, and a discussion of the several uses that we have made of the instrument.

2. BACKGROUND

The exam was developed in the mid-2000's as an outgrowth of a national certification exam project, and for use at the co-authors' university—the University of South Alabama (USA), located in Mobile, Alabama. Available from the Center for Forensics, Information Technology, and Security, the USA-CFITS DB Exam consists of 25 multiple choice items, 16 of which appear on the IS 2002 exit exam, a national certification exam for information systems exit skills (Landry, Reynolds, & Longenecker, & 2003).

The original reason for creating the exam was to address a graduate program placement issue. Students admitted to the information systems master's program had traditionally been placed into the graduate data management course based on the prerequisite of having passed an undergraduate database course. Despite having transcript evidence of an undergraduate database management course at other institutions, some students were not prepared to succeed in our graduate database course. Since our undergraduate course was designed to satisfy course objectives consistent with learning units in IS 2002 and since graduate students who successfully completed our undergraduate database course also successfully completed the graduate database course, we concluded that a placement exam was needed to accurately determine when the undergraduate course should be a required prerequisite. Subsequently, the database placement exam was created to be given to incoming master's students, and used as a placement mechanism. Students making a passing score were admitted to the graduate data management course, while students making a failing score were advised to complete the undergraduate database course with a passing grade of 'C' or better.

Development and Validation of the Exam

The USA-CFITS DB Exam was originally designed to be a measure of data management knowledge and skills, one of the fundamental core areas of Information Systems curricula (Landry, Longenecker, Haigood, & Feinstein, 2000; Haigood 2001; Colvin 2008). The foundations for the exam are database-related learning units (LU) of IS curricula models, IS'90, IS'97, and IS2002 (Longenecker & Feinstein, 1991; Longenecker, Feinstein, Couger, Davis, & Gorgone, 1995; Davis, Gorgone, Couger, Feinstein, & Longenecker, 1997; Gorgone, Davis, Valacich, Topi, Feinstein, & Longenecker, 2003). The continuing relevance of database skills and knowledge in the IS curricula models is further supported by the results of two surveys—one targeting faculty and industry partners (Landry et al., 2000) and a second targeting IS professionals two to four years beyond graduation (Colvin, 2008).

Specific knowledge and skill areas used to motivate item writing for the USA-CFITS DB Exam were drawn from prior work reflecting an intersection of academic and professional needs. Henderson, Champlin, Coleman, Cupoli, Hoffer, Howarth, Sivier, Smith, & Smith (2004) published a framework for Data Management curricula intended for postsecondary education and sponsored by a professional society, the Data Management Association (DAMA). Longenecker, Henderson, Smith, Cupoli, Yarbrough, Smith, Gillenson, & Feinstein (2006) studied this framework in detail and found that the skills were compatible with the IS2002 and IS2010 IS curriculum guidelines. Table 5 in the appendix reflects a synthesis of the DAMA framework, the IS model curriculum guidelines, and a job ad analysis (Landry et al., 2000; Haigood 2001).

In developing the USA-CFITS DB Exam to reflect both professional skills and curriculum guidelines, the authors wrote items that assessed the intersection of a data management sub-skill area and an IS 2002 learning unit. The learning objectives for each of the 25 items on the USA-CFITS DB Exam are as follows:

1. Given a piece of data to programmatically manipulate, choose the appropriate data type
2. Given a real-world application, determine appropriate fields to be stored in a file
3. Choose and defend the correct data type for representing a common data attribute
4. Differentiate between entities and attributes when developing an ERD
5. Recognize the need either for an intersection table in a M:N relationship or the need to revisit requirements to determine if there is a missing entity

6. Given a relational database description, evaluate the architecture
7. Given a system need, such as access control to a database, identify the necessary information
8. Differentiate among alternatives for enforcing data integrity constraints
9. Compare and contrast the processes involved in data modeling
10. Recognize the implication of a cascade delete
11. Recognize the notation of standard ER models
12. Recognize and describe a correct three-entity solution to a problem expressed as a many-to-many relationship between two entities
13. Recognize that many-to-many relationships require a third, linking table in a relational DB
14. Apply the knowledge of using a stored procedure to enhance the performance in a database environment
15. Given database design goals, identify correct techniques for implementation
16. Normalize (redesign) an unnormalized (poorly designed) table
17. Recognize correct syntax and correct use of views
18. Recognize the implication of using views in a client application
19. Recognize the advantages and disadvantages of implementation with stored procedures
20. Trace and debug SQL syntax
21. Recognize the correct formulation of a query
22. Differentiate normal forms as part of database design
23. Recognize which tasks are associated with discovering and eliciting database design requirements in the initial phase of requirements analysis
24. Recognize relevant factors involved in the purchasing decision of a major enterprise level DBMS package
25. Recognize properties of the Entity-Relationship Model, particularly the concept of minimum cardinality

Since the development of the USA-CFITS DB Exam, a revision of the information systems curriculum guidelines has been issued. IS 2010, available at http://www.acm.org/education/curricula, defines core course IS 2010.2 as *Data and Information Management*. All 25 USA-CFITS DB Exam items map to a stated course objective of the IS 2010.2 course. Of the 25 items, 13 of them map to course objectives 6, 8, and 12, dealing with conceptual data modeling, designing a high quality database, and various SQL commands, and 13 of the 21 course objectives are covered by at least one exam item.

The exam item objectives were also mapped to ABET student outcomes criteria (ABET, 2007, p. 14). The outcomes criteria, along with the number of exam items mapped to each, are shown in Table 1. See Table 5 in the appendix for a grand mapping of the 25 item objectives with IS 2002, IS 2010 and ABET.

Table 1 - Coverage of ABET Student Outcomes

	Student Outcomes that must be enabled	Number of associated exam item objectives
The program has documented measurable outcomes that are based on the needs of the program's constituencies	(a) An ability to apply knowledge of computing and mathematics appropriate to the discipline	1
	(b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution	5
	(c) An ability to design, implement and evaluate a computer-based system, process, component, or program to meet desired needs	12
	(i) An ability to use current techniques, skills, and tools necessary for computing	7

It is important that an internal exam designed for assessment be mappable into multiple assessment frameworks. Doing so strengthens the validity of the exam's content as being relevant outside of the local unit's needs. For more on the approach used to map multiple assessment frameworks, write items, and validate exams, see related papers (Landry et al., 2003; Landry , Daigle, Longenecker, &

Pardue, 2010; Reynolds, Longenecker, Landry, Pardue, & Applegate, 2004).

Exam Construction

The multiple mappings established a useful foundation for item writing, which was carried out using these and other good practices in educational assessment (Hogan 2007; Crocker & Algina 1986). The writers wrote items and objectives in alignment with mapped frameworks. An item consisted of a stem with four possible answers with one correct answer. Good item writing was difficult, and multiple reviewers were utilized in the item review process. The entire item-writing and review process was supported by a web-based exam delivery system developed by the co-authors and their graduate students at the University of South Alabama. The candidate items were pilot tested, revised, and validated with statistical techniques, including test item statistics. See Section 3 – Validation below for details. A summary of recommended practices includes the following:

- Define objectives, and write items that target the objectives
- Map items into other outcomes for assessment value
- Don't write items that are too difficult
- Make sure items are based on knowledge
- Get multiple reviewers to rigorously review items, and correct
- Pilot test the exam
- Use test item statistics to validate
- Make exam easy to administer and score
- Select an appropriate passing score
- Develop good security policies

See Figure 1 for an overview of the item construction process.

A cut score for passing was set at 44% correct responses. The success rate of students in our graduate database course correlated with whether the student made at least a 44. A score of 44 correlated with a midrange 'C' performance in our undergraduate database course. While the score of 44 would seem low for a student who has taken a database management course, an explanation is that scores for this external exam are predictably lower than scores on internal assessments that reflect an individual instructor's preferences in instructional approach and topic emphasis. Furthermore, we designed the items on the exam to be discriminating, that is, to differentiate between those who know and those who don't, perhaps to a higher degree than instructors do in general.

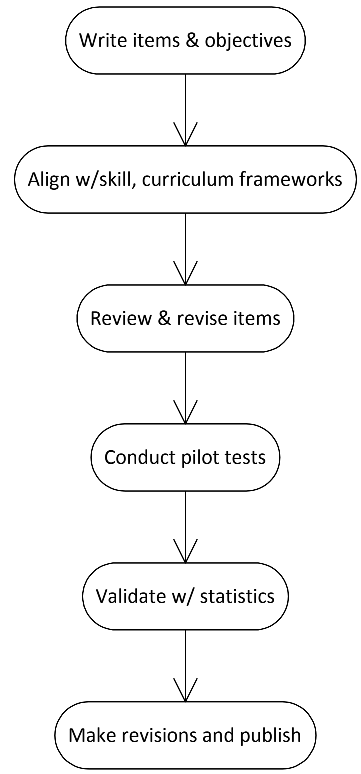

Figure 2 - Item Construction Process

Multiple Uses of the Exam

The faculty eventually found multiple uses for the exam in addition to graduate data management course placement. In the undergraduate database course, the exam is given as a pre-test at the beginning of the course and as a post-test incorporated as part of the final exam. This practice provides the capability of assessing the degree to which the undergraduate database course is achieving its intended learning outcomes, independent of instructor assignment (especially part-time instructors) and in different delivery formats (traditional, blended, fully online). This results are used as a formative program assessment method for both ABET and regional accreditation agencies (e.g. SACS).

3. VALIDATION

The results of using the exam over three years are described next. The first test described is a test using content experts. This test was intended as a face validity test, but also demonstrated content validity. The panel of experts, which consisted of professors from the university using the exam, took the test as a student would, in a proctored lab environment.

Overall, observations made by the experts included a perception that the test items are discriminating, that is, they are effective at discriminating between whether someone knew the answer or would have to guess. The perception among the content experts is testable. See discussion of item validation and pre/post testing below. Another positive reaction from an expert after taking the test was that "I knew what the item was about, but don't know if I got it right." This comment was interpreted as meaning the item was about a relevant database concept familiar to the expert, but that the item was also challenging. Another expert said that it was helpful that the exam had a consistent format of diagrams and tables that accompanied some of the items, as well as re-use of data in tables. Such consistency cuts down on the cognitive overload on takers. The eight items (of 25) that use tables or figures depict ER models, queries, or tables/views of data. One expert liked the "normalization item", another liked the item on "intersection tables" (which table gets the foreign key?").

More critically, the experts thought that "four or five items need revisiting (more review)." Some jargon was recognized as being potentially confusing to students, including the use of United States zip codes on a data types item. The toughest items were believed to be those on triggers and constraints. The experts were skeptical of items that presumed a specific order of database life cycle activities. Another item asked about the "best way" to do something, and it was believed the item to be too normative.

The second set of tests we conducted was to run statistical analyses on the most recent set of test taker data. We calculated summary and item statistics, and conducted pre/post tests, and ran correlations of test vs. course performance.

Summary and Test Item Statistics

From January 2008 until May 2010, a total of 246 USA students, a combination of graduate and undergraduate students, English speaking and ESL students, took the USA-CFITS DB Exam. Over this period, 53.4 was the mean score with standard deviation of 14.6. This score is consistent with national norms for the information systems exit exam. The highest score was a 92, and the lowest score was a 16. Eight test takers, or a little more than 3 percent of all takers, scored below 25, or worse than guessing.

The KR20, which measures internal item consistency, was 0.62. The score is right above a minimally acceptable score of 0.60, which is recommended for tests in a subject domain taken by those trained in that domain.

Table 2 - Item Statistics

Pct Correct	Point Biserial
43	0.45
64	0.36
58	0.24
65	0.46
40	0.40
50	0.51
80	0.30
54	0.26
58	0.25
34	0.20
40	0.12
81	0.41
75	0.43
86	0.19
32	0.34
58	0.14
72	0.26
28	0.21
87	0.29
30	0.51
39	0.36
53	0.34
26	0.30
28	0.30
46	0.44

Some test item statistics are provided in Table-2 below. This table indicates the percentage of subjects getting each item correct, which varies from 26% to 87%, and the point biserial, which varies from .12 to .51. The percent correct scores indicate item difficulty on a 100-point scale, with a 100 representing the easiest (least difficult) item, that is, with 100% of takers answering it correctly. Higher point biserials are indicative of items that correlate well with the exam as whole, especially when values are 0.40 and higher.

Pre and Post tests

The purpose of a pre/post test is to demonstrate that learning took place between the two measurements. In our case, we gave the USA-CFITS DB Exam to incoming graduate students. Those (25 students) who failed to make a passing score were required to take an undergraduate database course, and three other students who barely passed also decided to take the database course.

Table 3 - Pre/Post Test Results

Taker #	**Pre-test score**	**Post-test score**	**Difference b/w pre & post**
1	24	52	28
2	32	48	16
3	36	56	20
4	28	52	24
5	16	56	40
6	40	56	16
7	28	60	32
8	36	68	32
9	40	76	36
10	48	68	20
11	44	68	24
12	32	44	12
13	24	44	20
14	40	48	8
15	40	48	8
16	20	40	20
17	40	48	8
18	32	32	0
19	64	72	8
20	24	56	32
21	40	68	28
22	36	36	0
23	32	48	16
24	32	44	12
25	40	52	12
26	40	60	20
27	40	56	16
28	36	44	8
# Failed	**25**	**3**	
# Passed	**3**	**25**	
Total takers	**28**	**28**	
Pct takers passed	**11%**	**89%**	
Mean score (0-100)	**35.1**	**53.6**	**18.4**

At the end of the database course, they again took the placement exam. These two sets of scores were compared using a paired t-test, using PASW Statistics. There were 28 students in the sample. The pre/post test scores are in Table 3 as follows.

By the end of the course the results were reversed. There were now 25 passing scores and three that were still below passing (although one of those improved by 20 points) for a pass rate of 89%. The pre-test mean was 35.1, compared to a post-test mean of 53.6. The mean difference was 18.4 points, and the result of a paired differences test was statistically significant at a .001 level (p=.000). Such a result is a strong indicator of learning taking place in the course. It was particularly remarkable that the increase in scores occurred despite the fact that many of the students in the sample had prior database experience and scored close to passing in the pre-test.

If the test maps well to the objectives of the course, and the pre-test is given to those with little knowledge of the subject matter, a pre/post test design ought to detect whether learning is taking place. In this way, we can use the USA-CFITS DB Exam to verify that the undergraduate course is achieving its planned learning outcomes, over time, especially as the instructor changes. Once a pre/post relationship is established, it might be sufficient just to give the post-test, and compare the post test mean to historical post-test averages.

Correlations of test taker performance vs. database course performance

Over time (see Table 4), we determined that the scores on the exam correlated as follows:

Table 4 - Exam-Course Correlations

Score on USA-CFITS DB Exam (% correct)	Associated letter grade in the course
60-100	A
50-59	B
40-49	C
30-39	D
0-29	F

The grading scale on an exam like this is not the same as a typical 10-point scale used commonly in universities, with 90-100 A, 80-89 B, etc. The items on the exam, while representative of a first database course, are not particular to a specific institution's database course or its instructor.

We believe that instructors taught the database course in an unbiased manner towards the exam. It should be noted that that data includes scores from students in sections taught by two of the co-authors, one of whom also developed questions for this exam. The co-author's approach in teaching the course was not to teach to the test, nor use exam items elsewhere in the course. The other instructors had no access to the exam items before, during, and after the pre/post tests.

4. CONCLUSION

In summary, the benefits of using the exam are as follows:

- Maps to ABET outcomes
- Provides instructor-independent assessment of learning
- Can use as a placement exam for grad program or transfer students
- Useful for outcomes assessment for ABET accreditation
- Useful for course assessment

With the growing demand for more outcomes-based assessment in higher education, the use of this type of internally-developed exam, while becoming necessary, will offer many benefits. Among these are instructor-independent course and program outcomes assessment that supports multiple frameworks. We have shown that the USA-CFITS DB Exam is aligned with international curriculum models, ABET outcomes and job-related skills from two surveys (Landry et al., 2000; Colvin, 2008). With the specific exam being described, the USA-CFITS DB Exam, we have provided evidence that success in a first database course is most closely correlated with mastery of a specific subset of learning outcomes in data management. We described how we were able to converge on a cut score that predicted whether or not a graduate student needed to take a database prerequisite course. We provided evidence that post-test student scores parallel their local course performance, while trending lower than local scores for predictable reasons (i.e. exam is not specific to an instructor or the local course). All this made the exam useful for student placement and course assessment.

We believe that the need for more and better assessment helps make efforts like ours worthwhile. To inquire about use of the exam, contact the University of South Alabama Center for Forensics, Information Technology, and Security (USA-CFITS, http://www.usacfits.org).

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Editor's Note:

This paper was selected for inclusion in the journal as a ISECON 2012 Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2012.

APPENDIX: Table 5 - Grand Mapping of the USA-CFITS DB Exam

Skill		Skill Words
1.1.3	Data Types and File Structures	analysis, design, development, debugging, testing, simple data structures (arrays, records, strings).

#	ABET Outcome	LU	IS2002 LU-Title	IS2002 LU-Goal	IS 2010	Outcome	Item Objective	% Correct	PtBi Ser	Group Avg% Correct
1	b Analyze	58	Problem Solving, with Files and Database	to present and ensure problem solving involving files and database representations	2.113	Implement a relational database design using an industrial-strength database management system, including the principles of data type selection and indexing.	**given a piece of data to programmatically manipulate, choose the appropriate data type**	0.43	0.45	**0.55**
2	b Analyze	42	Information Measurements/ Data /Events	to present the concept that data is a representation and measurement of real-world events	2.05	Apply information requirements specification processes in the broader systems analysis & design context.	**given a real-world application, determine appropriate fields to be stored in a file**	0.64	0.36	
3	b Analyze	58	Problem Solving, with Files and Database	to present and ensure problem solving involving files and database representations	2.11	Implement a relational database design using an industrial-strength database management system, including the principles of data type selection and indexing.	**choose and defend the correct data type for representing a common data attribute**	0.58	0.24	

1.3.1	**Modeling and design, construction, schema tools, DB systems**	Data modeling, SQL, construction, tools -top down, conceptual, logical and physical designs; scripts; bottom up designs; schema development tools; desk-top/enterprise conversions; systems: Access, SQL Server/Oracle/Sybase, data warehousing & mining; scripts, GUI tools; retrieve, manipulate and store data; tables, relationships and views

13	a Basics	89	ADTs: Database Models and Functions	to develop awareness of the syntactical and theoretical differences between database models	2.11	Implement a relational database design using an industrial-strength database management system, including the principles of data type selection and indexing.	**recognize that many-to-many relationships require a third, linking table in a relational DB**	0.75	0.43	
23	b Analy ze	111	IS Requirement s and Database	to develop requirements and specifications for a database requiring multi-user information system	2.07	Link to each other the results of data/information modeling and process modeling.	**recognize which tasks are associated with discovering and eliciting database design requirements in the initial phase of requirements analysis**	0.26	0.30	
25	b Analy ze	111	IS Requirement s and Database	to develop requirements and specifications for a database requiring multi-user information system	2.08	Design high-quality relational databases.	**recognize properties of the Entity-Relationship Model, particularly the concept of minimum cardinality**	0.46	0.44	**0.50**
6	c Build	81	IS Database Applications Development	to develop application skills for implementing databases and applications by operating and testing these databases	2.06	Use at least one conceptual data modeling technique (such as entity-relationship modeling) to capture the information requirements for an enterprise domain	**given a relational database description, evaluate the architecture**	0.50	0.51	
8	c Build	81	IS Database Applications Development	to develop application skills for implementing databases and applications by operating and testing these databases	2.08	Design high-quality relational databases.	**differentiate among alternatives for enforcing data integrity constraints**	0.54	0.26	
10	c Build	88	IS Data Modeling	to develop skill with data modeling which describe databases	2.06	Use at least one conceptual data modeling technique (such as entity-relationship modeling) to capture the information requirements for an enterprise domain	**recognize the notation of standard ER models**	0.34	0.20	

11	c Build	88	IS Data Modeling	to develop skill with data modeling which describe databases	2.06	Use at least one conceptual data modeling technique (such as entity-relationship modeling) to capture the information requirements for an enterprise domain	**recognize and describe a correct three-entity solution to a problem expressed as a many-to-many relationship between two entities**	0.40	0.12	
12	c Build	88	IS Data Modeling	to develop skill with data modeling which describe databases	2.15	Understand the basic mechanisms for accessing relational databases from various types of application development environments.	**compare and contrast the processes involved in data modeling**	0.81	0.41	
16	c Build	90	IS Database and IS Implementati on	to develop skill in application of database systems development and retrieval facilities needed to facilitate creation of information system applications	2.10	Design a relational database so that it is at least in 3NF.	**normalize (redesign) an un-normalized (poorly designed) table**	0.58	0.14	
21	c Build	92	IS Database Application Implementati on	to develop skill with application and physical implementation of database systems, using a programming environment	2.12	Use the data definition, data manipulation, and data control language components of SQL in the context of one widely used implementation language.	**recognize the implication of using views in a client application**	0.30	0.51	
4	i Tools	58	Problem Solving, with Files and Database	to present and ensure problem solving involving files and database representations	2.06	Use at least one conceptual data modeling technique (such as entity-relationship modeling) to capture the information requirements for an enterprise domain	**differentiate between entities and attributes when developing an ERD**	0.65	0.46	
21	i Tools	92	IS Database Application Implementati on	to develop skill with application and physical implementation of database systems, using a programming environment	2.12	Use the data definition, data manipulation, and data control language components of SQL in the context of one widely used implementation language.	**recognize correct syntax and correct use of views**	0.39	0.36	

1.3.2		**Triggers, Stored Procedures, Audit Controls: Design / Development**				Triggers, audit controls-stored procedures, trigger concepts, design, development, testing; audit control concepts/standards, audit control Implementation; SQL, concepts, procedures, embedded programming (e.g. C#)				
5	c Build	81	IS Database Applications Development	to develop application skills for implementing databases and applications by operating and testing these databases	2.06	Use at least one conceptual data modeling technique (such as entity-relationship modeling) to capture the information requirements for an enterprise domain	**recognize the need either for an intersection table in a M:N relationship or the need to revisit requirements to determine if there is a missing entity**	0.40	0.40	
15	c Build	90	IS Database and IS Implementation	to develop skill in application of database systems development and retrieval facilities needed to facilitate creation of information system applications	2.11	Implement a relational database design using an industrial-strength database management system, including the principles of data type selection and indexing.	**given database design goals, identify correct techniques for implementation**	0.86	0.19	**0.57**
15	c Build	90	IS Database and IS Implementation	to develop skill in application of database systems development and retrieval facilities needed to facilitate creation of information system applications	2.14	Understand the concept of database transaction and apply it appropriately to an application context.	**apply the knowledge of using a stored procedure to enhance the performance in a database environment**	0.32	0.34	
17	c Build	92	IS Database Application Implementation	to develop skill with application and physical implementation of database systems, using a programming environment	2.12	Use the data definition, data manipulation, and data control language components of SQL in the context of one widely used implementation language.	**recognize the advantages and disadvantages of implementation with stored procedures**	0.72	0.26	

18	c Build	92	IS Database Application Implementation	to develop skill with application and physical implementation of database systems, using a programming environment	2.12	Use the data definition, data manipulation, and data control language components of SQL in the context of one widely used implementation language.	**trace and debug SQL syntax**	0.28	0.21	
19	c Build	92	IS Database Application Implementation	to develop skill with application and physical implementation of database systems, using a programming environment	2.12	Use the data definition, data manipulation, and data control language components of SQL in the context of one widely used implementation language.	**recognize the correct formulation of a query**	0.87	0.29	
22	c Build	95	IS Database Conceptual/Logical Models	to show how to design a conceptual relational database model and logical data base model, convert the logical database designs to physical designs, develop the physical database, and generate test data	2.09	Understand the purpose and principles of normalizing a relational database structure.	**differentiate normal forms as part of database design**	0.53	0.34	
1.3.3		**Administration: security, safety, backup, repairs, replicating**				monitoring, safety -security, administration, replication, monitoring, repair, upgrades, backups, mirroring, security, privacy, legal standards, HIPAA; data administration, policies				
24	b Analyze	111	IS Requirements and Database	to develop requirements and specifications for a database requiring multi-user information system	2.01	Understand the role of databases and database management systems in managing organizational data and information.	**recognize relevant factors involved in the purchasing decision of a major enterprise level DBMS package**	0.28	0.30	**0.54**

7	c Build	81	IS Database Applications Development	to develop application skills for implementing databases and applications by operating and testing these databases	2.17	Understand the key principles of data security and identify data security risk and violations in data management system design	**given a system need, such as access control to a database, identify the necessary information**	0.80	0.30	
1.3.6		**Data Quality: dimensions, assessment, improvement**				Data Accuracy, Believability, Relevancy, Resolution, Completeness, Consistency, Timeliness; Data definition quality characteristics, Data model / requirements quality characteristics; Data clean-up of legacy data, Mapping, transforming, cleansing legacy data; Data defect prevention; referential integrity; Data quality employee motivation, Information quality maturity assessment, gap analysis				
9	b Analyze	88	IS Data Modeling	to develop skill with data modeling which describe databases	2.18	Understand the core concepts of data quality and their application in an organizational context.	**recognize the implication of a cascade delete**	0.58	0.25	**0.58**
							Average % Correct ---->	**0.53**		

Note: The table is organized by sub-skills. Each row of the table shows the item number, the mapping of the item to the ABET program outcomes, IS 2002 Learning Unit (LU) number, LU Title and LU Goal statement followed by and IS 2010 learning outcome from IS2010.2 course. The item objective (in bold) was mapped to the IS 2010 learning outcome. The last three fields show the percent correct, and the point bi-serial correlation coefficient, and the average of percent correct for each sub-skill. Test items (not shown) were derived by first developing the Item Objectives (while studying the sub-skill and LU data) and then the Test Item was written.