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INFORMATION SYSTEMS EDUCATION JOURNAL

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"Consumerization of IT" - Challenges for IS Education

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Abstract

The quiet revolution of consumer IT reached a climax recently with the widespread adoption of smart consumer devices and their rapid penetration into enterprise IT applications. This significant change of attitude, as well as the reliance on information technology has been referred to as "Consumerization of Information Technology" (CoIT). CoIT has emerged with a global driving force that has been and will continue to reshape IT practices. This paper examines some of the IT challenges associated with CoIT, and relates them to Information Systems (IS) educational challenges.

Keywords: Consumerization, Net Generation, IS education

1. INTRODUCTION

The recent introduction of the iPhone and iPad has intensified the rapid shifting of global technological development emphasis towards a new ecosystem surrounding smartphones and tablets, creating new waves of technological and social changes collectively known as the "Consumerization of Information Technology" (CoIT). CoIT represents a disruptive change that has forced all organizations to reevaluate their relationships with stakeholders, especially the consumers and end users. CoIT has challenged the relative value of traditional enterprise Information System (IS) and by extension, the relative value of traditional IS educational programs that have been designed for the enterprise Information Systems. This paper examines some of the organizational challenges emerging from CoIT, and evaluates similar and related challenges in the IS Educational process. While it would be beyond the scope of this paper to precisely distinguish the two terms Information Systems (IS) and Information Technology (IT), it might be helpful to think of IS as the collection of software and captured data, residing on main-stream computer systems such as mainframe and PC, while IT would include IS and all consumer and office electronics and Internet based computational systems that exhibit the capabilities of traditional computers.

2. CONSUMERIZATION OF IT (CoIT)

CoIT first gained popularity in 2001, while the iPhone and iPad made "consumerized IT" the new normal (Clevenger, 2012). Although a concise, common definition of CoIT is being refined, CoIT represents a fundamental change in user expectation for technology, the selective usage of available technology, and radical changes in IT decision making, funding, and usage patterns. (Crawford, 2012; Microsoft, 2011; Dasher, 2012)

CoIT refers to the expectation of easy-to-use and attractive interfaces with intuitive functionality at low price or even zero cost (Golden, 2011). From the user's perspective, ease-of-use equates to near-frictionless availability of tools and solutions and the ability to use these tools with a transparent setup process, without assistance or intervention from IT support (Reinhard, 2012). From an inter-organization perspective, there must be well-documented, convenient interfaces that do not require the support of a joint engineering project team (Golden, 2011). A recent survey of over 3000 information workers and business executives in nine countries suggested that user owned devices represent up to 40.7% of the devices used for work purposes, hence there exists a need for application interfaces to work seamlessly with user owned devices (Gens, et.al., 2011).

Two fundamental driving forces behind CoIT have been the users and changes in the technology solutions (Crawford, 2012). Users can be roughly divided into three subgroups: senior executives, the Net Generation, and the rapidly growing number of users with access to a mobile device (Gainham, 2012). New technologies including smartphones, tablets, cloud services, mobile solutions and apps have been rapidly replacing the traditional roles of PC and software.

The senior executives are influential in moving the organization toward embracing and supporting CoIT. The recent wave of new consumer IT devices offer numerous attractive features for executives, who can easily afford the new IT as a personal device, or lead adoption of the new devices by the organization. Increasing array of lightweight devices with features such as instant-on, long battery life, mobile connectivity, touch interfaces, and vibrant displays storm the IT world creates a disruptive force that promises to change IT practices for years to come.

The Net Generation generally refers to children born after 1986. The Net Generation has yet to unleash its full influence in changing the perceived value of organizational IT. As active consumers of the new IT, they constantly impose pressure to upgrade IT services. As the new workforce and with a high level of IT awareness, they are influential in transforming the IT process with preference for the usage of personal devices they have been familiar with in their consumer life (Crawford, 2012; Gainham, 2012; Gens, et.al., 2011).They are IT savvy, and incline to question the relevancy of existing IT practices, pushing for changes in IS designs. The Net Generation potentially presents the greatest challenge for IS education (Law, 2011).

The last group of users includes workers that own mobile devices and consumers that embrace mobile devices as the preferred platforms for communication and information consumption. Many workers push the acceptance of "Bring Your Own Device" (BYOD) and other new technological solutions such as cloud services. A recent study showed that 70% of employees reported accessing corporate information from employee-owned devices compared to a 40% estimate by IT departments (Gruman, 2012). Collectively, these users generate numerous issues in terms of IT funding, data security, compliance, IT support and IS usage. As users make independent IT purchase decisions, less funding flows through the IT department, which also must shoulder the additional workload of supporting IT unfamiliar to the IT staff. When the IT department fails to provide adequate support services, the ending result could be an erosion of usage of enterprise IS through decentralized information management practices. Copies of data begin to flow through non-enterprise information infrastructures, creating redundancy and effectively eliminating the value contribution of enterprise IT investment.

3. CoIT AND CHANGES IN TECHNOLOGY SOLUTIONS

There have been major technological breakthroughs in the past decade, especially in innovative consumer IT that provide attractive substitutes for mainstream computational features. Some of the recent developments have created speculation that the personal computer could be phased out within years. Some of the more significant technological shifts include the move from (Hinchcliffe, 2011):

1. Graphic User Interface (GUI) to touch User Interface (UI) & mobile platforms.
2. Data center to cloud services.
3. PC to devices running Browser & Apps.
4. Email & web contents to social media.
5. Enterprise centric development to consumer centric development.
6. Databases & business intelligence (BI) to Big Data.
7. Enterprise IT infrastructures to personal IT infrastructure.
8. Centrally pushed IT applications to decentralized IT needs, pulling IT solutions.

Each of these areas of change has generated and will continue to generate significant research interests. The momentum of change has been speeding up in the last 12 months, especially in the first five areas. The next section of this paper examines some indicators of change and draws attention to associated IS educational challenges.

4. CoIT TECHNOLOGY SHIFT AND IS EDUCATIONAL CHALLENGES

The migration away from GUI to touch UI & mobile platforms effectively tore down the last barrier to a digital society. According to recent Pew surveys, 88% of American adults age 18+ owned at least one mobile device, with 46% of adults owning a smartphone, and 63% going online wirelessly with one of those devices (Web, 2012). Now users can perform intensive computational tasks at various times and locations, with minimal training and effort. The attractive touch UI made campus IT seem antiqued. The restrictive IT facilities on campuses suddenly became a burden to a new style of learning. The artificial schedules of class meeting and contact hours also became less meaningful with the capability for virtual meeting, online media and real time interaction. The "instruction" of a class could commence with "instructional activities" up to six months prior to the first class meeting, when students started to "interact" with the instructor concerning class activities, learning resources, data storage and supporting IT. When students gradually turned to a continuous learning process, aided by IT supported virtual learning, it became more difficult to plan, justify and support campus-based IT facilities, which were designed for event-based learning. Thus, innovative instructional design and delivery approach is an emerging challenge for IS education to capture the interest of a new generation of students.

Cloud services have been filling the void of restrictive institutional data centers. The surge in data flow also tested the service capacity of data centers, forcing users to turn to free or low cost cloud services for more predictable access. Some examples include websites, course materials download, and electronic forums. As students expected 24/7 access, easy authentication process, and smooth user interface experience, it became difficult to rely solely on institutional data center for instructional support. Thus, migration of learning resources to public cloud services is a worthy option to capture the passion of students towards IS education.

For many years, the focus of IS education has been in helping students to learn application development tools and eventually acquire the skills to create custom application software. The emergence of Apps raises many challenging questions - "Why should a student learn spreadsheets when there are Apps for the common tasks?", "Why should someone learn HTML script coding when one can create a working website through a point and click Web Builder?", "Why does one need a PC when all the needed tasks can be accomplished through a browser on a mobile device?". The challenge remains to convince students that they have been given a relevant and valuable educational experience. Thus, a new direction could be in the decoupling of the mastering of IT tools from the assembly of the IT toolbox, preparing students for rapid changing workenvironment. A key challenge would be in finding ways to release the creative energy of students and to explore the potential of powerful IT tools that are yet to be adopted into the academic toolbox.

A surprising trend has been the increasing time people spend in social media. In the process, users neglected the communication channels of email and websites. Thus there is a need to reassess the roles of email and websites as effective communication platforms. At the same time, it would be fruitful to explore the potential of social media for instructional support, for team projects, and for research on emerging IT needs and interests. As a result, there will be a need to redefining learning and learning outcomes, to develop new assessment tools for a shared learning environment, and to reconsider the roles of information channels in the educational process, for example, the relative roles of textbook, ebook, website, eforum, and social media.

While enterprises have been shifting their IT resources to consumer centric development, there is a need for rapid retooling to include this development in IS education. Many students now have access to affordable, sophisticated personal IT infrastructure, unmatched by the IT infrastructure provided by educational institutions. Moreover, existing relational database systems can no longer handle the massive data stream in a scalable and cost effective manner. A major challenge would be to take students from classroom cases with limited data to gain experience working with massive data volume. The slowdown in enterprise centric development also indicates a need to adjust the forecast for demand for IT talent in enterprise system related activities.

5. NET GENERATION AND IS EDUCATIONAL CHALLENGES

The reality of CoIT raises an extremely important question: "Will there be sustainable demand for the current IS educational products?" For many years, IS programs have housed the best collection of IS learning resources for students. CoIT reflects a change in attitude toward IT, especially among the Net Generation. By 2012, The Net Generation accounted for a majority of the students on university campuses (Internet Generation, 2012). As avid users of computers and the Internet, the Net Generation demonstrates much less tolerance of boredom than previous generations. They learned just in time, loved experimentation, with preference for web-based tools and services. They were less inclined to follow a curriculum, neither would they equate hard work with learning (Smith, 1999; Hay, L.E. 2000).

The Net Generation grew up through the development of CoIT. They are more likely to own the latest generation of consumer IT than previous generations. They surf the Internet for information rather than reading textbooks, they turn to Google and Wikipedia for references rather than visiting a library. They are skilled in locating tools and web services for task completion. Many of them enjoy access to better technology and better IT infrastructure than those provided by academic institutions. They do not hesitate to request special accommodation to meet their diversified interests. As a highly mobile generation, they demand the availability of technology at their choice of time, location and communication channel.

At the same time, it has been challenging to motivate the Net Generation into deep learning, particularly when they have been pampered with the convenience and ease-of-use of CoIT. The ease of finding information, the availability of quick tools, and even the flood of opinions from social media, represent factors that tend to weaken the problem solving skills of the Net Generation. This could be particularly challenging when trying to train future IS designers, who must be objective and analytical.

The Net Generation is known to be curious, independent, contrarian, intelligent, adaptable, confident, and focused (The Net Generation, 2000). Often this translates to failure to follow detailed instructions. The Net Generation is inclined to have problems follow a training schedule - some desire to focus and work ahead of schedule; others sidetrack to related topics, and some dwell on excessive details of a topic while neglecting the schedule and requirements. This often creates unplanned challenges in "controlled learning environment," where each student has been expected to complete prescribed works, on rigid schedule, around the use of standardized, institutional provided IT and IT infrastructure.

6. RETHINKING THE INTERPRETATION OF IS 2010 CORE COURSES AND CoIT

There have been drastic shifts in global acceptance of CoIT in the last two years since the announcement of the IS 2010 curriculum recommendation (IS010, 2010). CoIT presents new challenges that merit consideration in IS curriculum revision efforts, as follows:

1. Foundations of Information Systems
CoIT accounted for 40% of enterprise IT usage and over 50% of US adult IT usage.A recent straw poll of students in an Introduction to Computer general education course showed that nearly 50% of the enrolled students own a MacbookPro. Other students captured pages of book withsmartphones, and routinely swapped assignments through cloud services.However, these are not the typicalIT practices covered in textbooks and core topics, nor do students indicate much interest in the traditional topics such as Windows system,and data storage technology.The pressing questions of relevancy, popularity, platform support, continuity, and IT ecosystem seem to command increasing importance in defining the desirable fundamental understanding of information systems. As IS education expands its scope from enterprise IS development to web applications and CoIT, it is important to include fundamental topicsrelevant to students pursuing different career paths.

2. Data and Information Management
Search engines are rapidly displacing database systems as the tool of choice in locating information, especially for the Net Generation. Although data processing activities and database systems are still the backbone for data management, customized user interfaces, smart sensors, semantic engines, and contents management systems have increasingly roles in the utilization of enterprise data. There are also needs to address data and information distribution issues, especially related to CoIT.

3. Enterprise Architecture

The spreading of data as a result of CoIT creates potential needs for a new design of Information Architecture, where both internally and externally sourced information must be blended to support enterprise mission. Mobile devices are becoming important tools for data collection and information dissemination, with a desirable shift in enterprise IT supports.

4. IT Infrastructure
The increasing role of cloud services suggests needed attention to outsourced services management and roles of individual consumer IT infrastructure. New skills must be developed to develop, manage and evaluate outsources services. Special attention would be required on compliance issues, data usage, data security issues and IT infrastructure interfaces. This is especially important towards supporting data sharing in the emergent multiplatform technological environment, especially the rapidly developing mobile platforms.

5. IS Project Management
CoIT enhances virtual interaction, making it desirable to address virtual project management and increasing consumer roles and participation in projects.The roles of social media are casting new meaning to project development, especially when users are given active roles in projects.

6. System Analysis and Design
CoIT points to the need for smart interface designs for enterprise systems. Web and browser based software development drives innovation and reshapes enterprise IS designs.Low cost and high speed hardware shifts attention to rapid development, with increasing emphasis on user experience.

7. IS Strategy, Management and Acquisition
Considering CoIT, increasing attention would be required for agile IS services, strategic IT alliances, shared IT resources and universal connectivity.As consumer spending becomes a major economic driver, Enterprise IS strategy development must also take into consideration information consumption pattern of end users, their preferences for IT platform, and the rising trend of bring their consumer life into work life.

7. CONCLUSIONS

Although CoIT seems to be remotely related to the enterprise IS at this stage, business executives and IT industries have taken this development seriously. Recent developments have already placed major IT vendors at the brink of fighting for survival, while others have abruptly modified IT strategies and core IT technology around the CoIT developments.

It is important for IS educators to participate in this evolving change, help define enterprise boundaries for CoIT, and prepare future IS leaders. The challenges will be great, confronting unfamiliar CoIT innovations, new tools, and new IT platforms. There is a need to recast the image and role of IS program, rethink the mission of IS curriculum, reposition the importance of innovation, rediscover the market needs, readjust to a new generation of learners, reassess desirable learning outcomes, redesign the IS learning experience, realign instructional resources, and retool to assess and evaluate student accomplishments, while building on the broadened student IT experience and interests beyond the business function.

The Net Generation has been raised through the evolution of CoIT, and to them, IT is fun and easy to learn and use. They have many available options for their computational tasks. How would IS education deepen their experience in the utilization and control of information technology? Furthermore, how would IS education develop them to add value to enterprise IS application needs?

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Developing an Undergraduate Information Systems Security Track

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ABSTRACT

Information Systems Security as a specialized area of study has mostly been taught at the graduate level. This paper highlights the efforts of establishing an Information Systems (IS) Security track at the undergraduate level. As there were many unanswered questions and concerns regarding the Security curriculum, focus areas, the benefit of certifications, and limited experience of undergraduate students, we reviewed prior literature and conducted in depth semi-structured interviews of industry executives that are responsible for the security portfolio within their organizations. We present findings that can benefit not only our efforts but also other schools that plan to offer similar programs at an undergraduate level.

Keywords: Undergraduate curriculum, Information Systems Security, Information Systems

1. INTRODUCTION

State government budget crises in recent years have led to significant funding cuts to the budgets of many public universities and colleges (Carter, 2012). These budget issues have increased emphasis on accountability measures, including job placement rates (Akey, 2012). For example, the University of North Carolina (UNC) university system requires that “employment opportunities” be considered a basis for establishing new academic programs (UNC, 2008).

In terms of employment opportunities, Information Systems Security, as a program area, would seem to meet this criterion. As computer systems, networks, and network applications proliferate in both corporate and consumer usage, the availability of Security professionals continues to be an issue. For example, a recent study (Ayoub, 2011) forecasts the compound annual growth rate (CAGR) of jobs for Security professionals during the 2010-2015 period to be 13.2% worldwide.

This paper documents the research and decision-making process that one academic department went through to establish an Information Systems Security track in its curriculum. The paper is organized as follows. After more detailed background on our specific circumstances, we summarize the literature on Information Systems Security curriculum development; present our findings from interviews with local Security professionals; and finally, discuss what these findings mean for the Information Systems Security track.

2. BACKGROUND

North Carolina Central University is primarily a liberal arts school with approximately 8,300 students. The School of Business offers a bachelor's of science degree in Computer Information Systems. In 2010, facing serious state funding cuts, the university embarked on a complete and thorough evaluation of all programs. As a result, some programs were cut and others were combined. Schools and faculty were rearranged. By 2011, the School of Business was facing its own challenges with a new dean in an accreditation year. The dean's first initiative is to develop and implement an effective strategic plan for the university. This strategic plan includes evaluating our own programs and realigning with the changing markets and our new strategic initiatives.

Keeping this strategic plan in mind, the Computer Information Systems discipline was assigned its own challenge. Under the direction of the new dean, the Chancellor required the School of Business to develop a new program. As a part of our new program we developed four tracks (Business Analysis, Network Administration, Bioinformatics and IS Security). In establishing the new Information Systems Security track there were still some unanswered questions that were critical to its success. Among the questions we wanted answered initially were:

- Specifically, what content should be in the Security curriculum?
- Should we offer certifications in Security, and if so, which one(s)?
- What should faculty qualifications be to teach courses in the Security track?

3. LITERATURE REVIEW

It has been estimated that today's computer systems are less secure than equivalent systems of just ten years ago, with our systems growing more vulnerable with every passing year (Garfinkel, 2012). Security research scientist Simson Garfinkel (2012) goes on to assert that the issue is not being adequately addressed, as currently "most computer professionals receive little if any training in Security, most CS professors and software engineers try to ignore it, and there are few Security specialists." Swart (2007) agrees that the "lack of inclusion of IT security in the curriculum has led to significant risk for companies."

Program Content in Current Programs

Although the need for higher education institutions to train future computer professionals regarding Security is clear, what is not so clear is the specific content of the curriculum. Even the name of the curricula, and the specific discipline area offering such curricula, vary widely. Names for the field include Information Assurance, Information Security and Computer Security (Wikipedia, 2012), ordered from broad to narrow. Other names include Information Security and Assurance, Network Security (Swart, 2007), Information Systems Security (e.g., Ralevich & Martinovic, 2010) and Cybersecurity (Smith, Koohang, & Behling, 2010). Discipline areas hosting these programs include Business, Computer Science, Computer Engineering (Swart, 2007), Information Science (Ralevich & Martinovic, 2010) Computer Information Systems, and Management Information Systems (Smith, Koohang, & Behling, 2010).

Even within similar program names or discipline areas, there is no standard content for Security in the curriculum (Perez, et al., 2011; Swart, 2007; Whitman & Mattord, 2004, 2006). Programs can specialize in Security, offer a specific course or courses in Security, or integrate Security throughout the curriculum. Courses/programs can focus on technical aspects, managerial aspects or a balance of both (Whitman & Mattord, 2004).

Some programs offer Security certifications by professional bodies, while some don't. With the exception of the CISSP certification (Certified Information Systems Security Professional, offered by the International Information Systems Security Certification Consortium, Inc., (ISC)²®), most certifications focus on the mastery of hands-on, technical skills (Swart, 2007). These certifications tend to be vendor-specific, and are more popular in Associates degree and certification programs (Perez et al., 2011; Swart, 2007; Whitted & Mattord, 2004). However, they often have articulation problems with four-year programs (Perez, et al., 2011). Petrova (et al., 2004) determined that their bachelor's degree program did not have room for providing a certification opportunity. Finally, it is not clear whether all or any programs need to have some form of certification as the outcome of the program (Cooper et al., 2009).

There are currently no ACM/AIS model curricula for a specialized program in Security. The IS 2010 curriculum model (ACM-AIS, 2010) provides for Security content integrated throughout the curricula, with electives in risk management, and audit and controls. The IT 2008 curriculum model (ACM-IEEE, 2008), which provides for the greatest coverage of Security topics, does not specify the degree of dedicated Security courses versus integration across the curriculum.

Skills Wanted by Industry in Graduates

There is very little research on what IS Security skills employers want colleges and universities to provide in their graduates. Whitted & Mattord (2006) say they get mixed responses from industry advisors to their program, also stating that most businesses have not developed explicit requirements for what it means to be an IS Security professional. After a focus group with local companies, Petrova (et al., 2004) concluded that "employers would prefer to hire IT graduates with broad knowledge but with specialized skills rather than specialists alone." This conclusion was confirmed by Swart (2007), who has performed the most comprehensive research to-date on the Security needs of industry:

> The results from the interview show that the information systems security function has evolved into a business oriented function. Significant time and attention are directed to protecting and educating users of information systems. IS security professionals are responsible for managing risk, demonstrating alignment between the IS security function and overall business objectives, and ensuring compliance with myriad regulations. Traditional IS security responsibilities involving monitoring networks and information systems to detect and respond to intrusions and attacks have not changed. These general results were consistent across each of the subjects interviewed. (pp. 111-112)

Regarding certifications desired by industry, Swart found that industry professionals have a strong preference for the Security Management and Audit focused certifications. This is consistent with the role of the IS Security professional expressed above. However, given that this is one study, done years ago in a rapidly changing field, more research would be useful for the development of academic IS Security programs.

Qualifications for Faculty Teaching Security Courses

One area about which the research literature has much to say, and with general agreement, is that Security curricula increase the difficulty of finding qualified faculty (Cooper, et al., 2009; Ralevich & Martinovic, 2010; Whitted & Mattord, 2004; 2006):

> One of the major constraints to the growth in student numbers is a difficulty in attracting and hiring new faculty with the adequate background and experience in IS security. Most of the experts and practitioners in the field, except for those with the related IS security certification, do not meet the criteria for teaching in the degree program, such as having at least a master's degree in a related field. Universities have a similar problem in recruiting faculty and that is one of the main reasons for a lack of such programs at the undergraduate level in North America or anywhere else. (Ralevich & Matinovic, 2010, p. 311)

Several researchers reported that certifications and conference attendance can be helpful to get four-year institution faculty up-to-speed for teaching Security courses (Frank & Werner, 2011; Ralevich & Martinovic, 2010; Whitted & Mattord, 2004). Due to the increased emphasis on certifications, instructors in associate degree programs are generally certified (Perez, et al, 2011).

4. DATA COLLECTION

Data Collection

In our effort to further understand the current needs in IS Security education we conducted 4 in-depth semi-structured interviews of industry executives who manage security within their organizations.

While a broader range of participants and more interviews would be better, we believe that ours is a representative sample which is sufficient to capture the key dynamics and highlight current trends and needs in IS security. To protect the identity of our respondents we have coded the responses using letters A through D. The profiles of the interviewees are summarized in Table 1 of the Appendix.

As is consistent with most exploratory qualitative studies most of the questions on the interview were open ended. The data was analyzed by coding the responses and identifying underlying themes and trends that emerged from the interview data. This approach is consistent with the contextual data analysis suggest by Krippendorff (1980).

5. DATA ANALYSIS AND RESULTS

Key themes and findings from the interviews have been summarized in Table 1 and Table 2 of the Appendix.

Based on our interview data we found that all interviewees felt that there is a growing need for security professionals and undergraduate students with limited experience have a good chance of securing employment provided they can demonstrate knowledge of key concepts in the security area.

Among the interviewees two favored a broad approach towards building a security track. According to interviewee C "the program curriculum should be a mile wide and an inch deep, because that will allow students to have their foot in the door. Most employers at the entry level do not expect depth." Interviewee D also favored a broad knowledge of the key areas but also suggested specialization for students in an area of interest. The broad curriculum for security could include common body of knowledge courses covering multiple domains similar to the content covered for CISSP certifications. The target job positions would be entry level positions such as junior network administrator or associate security analyst, threat analyst.

Interviewees A and B favored a more focused approach for the Security track. Their view was that deeper specialization of students allows them to differentiate themselves from the competition. Among the courses suggested for a focused approach were courses on compliance, network security and accounting. The target position for jobs would be Network Specialist, Compliance Specialist or Security Analyst.

All of the interviewees strongly favored certifications for students as an additional strength in the job market. All of them recommended the CISSP as a beneficial certification for students to have. Interviewees A and B also recommended the CCNA certification for students specializing in the networking area.

All of the interviewees strongly encouraged students to be a part of organizations such as the Information Systems Security Association (ISSA). Membership to organizations such as ISSA enables employers to connect with potential recruits and provide great networking opportunities for students.

One of key themes that emerged from all the interviews was that students should be able to understand the role of security within the context of business. According to Interviewee D "Students should have a broad understanding of what security is and what it does for the organization". Besides technical knowledge students should also be able to explain why they need to secure and why in a certain way. As interviewee A put it succinctly "they should be able to explain the why before the how".

Last but not the least all of the interviewees were of the view that having faculty that is certified sends a positive signal to the potential employers about the quality of the program.

6. CONCLUSION

The new program at NCCU has four suggested tracks of study, one of which is the Information Systems Security track.

Two challenges exist in developing an undergraduate degree track in Information Systems security. The first is that the field is quite broad. Every aspect of computer and Management Information Systems involves Information Systems Security. Second, a Security professional must know their "area" well in order to successfully secure it. In other words, in order to be successful, a Security graduate should have a "companion skill" as well (Swart, 2007). Most Security professionals have multiple years of experience in the domain that they eventually work to secure. As interviewee A had mentioned "you need to understand the network topology before you can secure it". All of the interviewees echoed similar concerns. Having domain knowledge assists the security professional to not only "keep the bad guys out" but also to "make sure that the good guys are able to work and get their work done" (Swart, 2007).

Unlike some of the other well-known programs in Security at other schools that are at the graduate level, we at NCCU are striving to build a successful undergraduate program in Security. Our objective is to produce a technically prepared Business professional who could be employed in the Security area of an organization with minimal experience. The purpose of this research was to interview Security professionals and ascertain key factors that would maximize our student's ability to secure employment and also determine the effectiveness of certifications for students and for faculty on this ability.

For the future we will continue to engage with industry executives and academic partners to build and grow our program into a successful template for undergraduate Security education.

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Appendix

Table 1: Interviewee Outlook on Security Program Recommendations

Inter-viewee	Interviewee Title	Scope	Membership Benefits for students (ISSA etc.)	Courses for Broad Program	Certifica-tions for Instructors	CISSP Benefit in Hiring
A	VP, Security Company	Focused	Yes	NA	Yes	Yes
B	Director, IT Solutions Company	Focused	Yes	NA	Yes	Yes
C	Network Engineer/Security Instructor in Banking and Education	Broad	Yes	Common body of knowledge for CISSP	Yes	Yes
D	Manager - Networking and Security, Telecommunications Company	Both Broad and Focused	Yes	Broad under-standing of security, CISSP Domain	Yes	Yes

Table 2: Interviewee Outlook on Target Positions in Security

Interviewee	Target Positions for Undergraduates	Courses for Target Positions	Certifications Preferred for Target Positions	Job Market for Target Positions
A	Network security, Compliance	Compliance, Basic Accounting, Networking	CCNA, CISSP	Good
B	Network Security specialist	Networking	CCNA, CISSP	Good
C	Threat Analysts, Penetration Testers, Security Analysts	Security courses based on CISSP Domain Knowledge	CISSP	Good
D	Junior Network administrator, Assoc. Security Analyst	Programming, CISSP Domains	CISSP	Good

A Design Quality Learning Unit in Relational Data Modeling Based on Thriving Systems Properties

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Abstract

This paper presents a learning unit that addresses quality design in relational data models. The focus on modeling allows the learning to span analysis, design, and implementation enriching pedagogy across the systems development life cycle. Thriving Systems Theory presents fifteen choice properties that convey design quality in models integrating aspects of aesthetics, the more subjective phenomena of satisfaction; a quality perspective more expansive than that usually found in software engineering, the traditional "objective" notion of metrics. Recent IS curriculum guidelines relegate software development to elective status confining design pedagogy into smaller and smaller pockets of course syllabi. Where undergraduate IS students may once have practiced modeling in analysis, design, and implementation across several courses using a variety of languages and tools, they commonly now experience modeling in two or three courses in at most a couple of paradigms. And in most of these courses their modeling focuses on acceptable syntax rather than achieving design quality in information systems. Learning design quality may once have been an osmotic side effect of development practice, but now it must be a conscious goal in pedagogy if it is to be taught at all. This learning unit is intended as an adaptable framework to be tailored to the coursework and the overall objectives of specific IS programs.

Keywords: design quality, design, relational data modeling, IS curricula, IS pedagogy

1. INTRODUCTION

Over the past decade computing curricula have been repartitioned with the permeation of computing across disciplines and society. (Shackelford, Cross, Davies, Impagliazzo, Kamali, LeBlanc, Lunt, McGettrick, Sloan & Topi, 2005) There are now 5 major guidelines that subdivide curriculum in the computing discipline. (Soldan, Hughes, Impagliazzo, McGettrick, Nelson, Srimani & Theys, 2004, Cassel, Clements, Davies, Guzdial, McCauley, McGettrick, Sloan, Snyder, Tymann & Weide, 2008, Diaz-Herrara & Hilburn, 2004, Lunt, Ekstrom, Gorka, Hislop, Kamali, Lawson, LeBlanc, Miller & Reichgelt, 2008, Topi, Valacich, Wright, Kaiser, Nunamaker, Sipior & de Vreede, 2010) The co-location of IS curricula in schools of business further exacerbates the pressure on pedagogy as accreditation bodies further constrain the scope of coursework by compressing systems development into smaller and smaller pockets of course syllabi. (AACSB, 2010, EQUIS, 2010) Where undergraduate IS students once may have practiced modeling in analysis, design, and implementation across six or more courses in a program using a variety of languages and tools, they commonly now experience modeling in four or fewer courses in at most a couple of paradigms. (Waguespack, 2011a) And in most of these courses their modeling decisions focus on acceptable syntax rather than principles representing and communicating concepts of quality in information systems. Where learning design quality may once have been an osmotic side effect of development practice it must now be a conscious goal in pedagogy if it is to be taught at all.

At the same time industry and academia persist in their lament over the paucity of focus on quality in system design first sounded more than four decades ago (Dijkstra, 1968) and echoing consistently since as in (Denning, 2004, Brooks, 1995, 2010, Beck, Beedle, van Bennekum, Cockburn, Cunningham, Fowler, Grenning, Highsmith, Hunt, Jeffries, Kern, marick, Martin, Mellor, Schwaber, Sutherland, & Thomas, 2010)

This paper presents a learning unit that teaches quality design in relational data models. The focus on modeling allows the learning to span analysis, design, and implementation enriching pedagogy across the systems development life cycle. Thriving Systems Theory presents fifteen choice properties that convey design quality in models integrating aspects of aesthetics, the more subjective phenomena of satisfaction; a quality perspective more expansive than that usually found in software engineering, the traditional "objective" notion of metrics. This learning unit is adaptable to the coursework and objectives of specific IS programs. The paper presents: a brief overview of design quality, properties to assess design choices, the relational ontology; and a discussion of how each of the design choice properties express quality through the use of relational data modeling constructs. Finally, there is a description of how the learning unit has been integrated in data management syllabi with a comment on its efficacy. A parallel treatment of design quality pedagogy applied to the object-oriented paradigm may be found in (Waguespack 2011b).

2. WHAT IS DESIGN QUALITY?

Quality is an elusive concept, shifting and morphing on a supposed boundary between science and art: objective, engineering characteristics versus subjective, aesthetic observer or stakeholder experience. International standards of quality reflect the challenge of defining quality by offering a variety of perspectives (as gathered here by Hoyle, 2009):

- A degree of excellence (Oxford English Dictionary)
- Freedom from deficiencies or defects (Juran, 2009)
- Conformity to requirements (Crosby, 1979)
- Fitness for use (Juran, 2009)
- Fitness for purpose (Sales and Supply of Goods Act, 1994)
- The degree to which the inherent characteristics fulfill requirements (ISO 9000:2005)
- Sustained satisfaction (Deming, 1993)

(Waguespack, 2010c) asserts that the quality of systems revolves around two primary concepts: efficiency and effectiveness defined as follows (New Oxford American Dictionary):

Efficiency [noun]- the ratio of the useful work performed […] in a process to the total energy [effort] expended

Effectiveness [noun]- successful in producing a desired or intended result

These two concepts appear primarily quantitative and therefore objective. In and of themselves they may well be. Portraying efficiency using a convenient interpretation of "work" and "effort" is genuinely objective. "How many" or "how much" or "how often" often depicts efficiency. But, when we ask "Is it enough?" apparent objectivity fades away.

Likewise, the supposed objectivity of "effectiveness relies upon the tenuous phrase, "desired or intended result" defined as

Intention [noun]- have (a course of action) as one's purpose or objective; plan

Effectiveness (like efficiency) is a correspondence between a system and its stakeholders' intentions. Assessing effectiveness depends on comparing "what is" to "what is intended." While the former may be expressed quantitatively the latter presents challenges: clarity of conception, mode of representation, scope of contextual orientation, and fidelity of communication to name but a few. Indeed the notion of effectiveness is complicated when we contemplate identifying and quantifying the stakeholder(s) intentions objectively.

The indefiniteness or imprecision that characterizes stakeholder intention(s) is generally not a concern if an observer is asked to assess the beauty of something – an assessment generally conceded to be subjective.

A detailed or even explicit intention is not expected in assessing beauty – beauty is most often perceived as an experience of observation rather than a system analysis.

Most people commonly accept beauty as subjective and exempt from specific justification or explanation – "Beauty is in the eye of the beholder." and "You'll know it [beauty] when you see it." This absence of or difficulty in forming a quantitative justification of beauty is often the basis for categorizing artifacts or processes as products of art rather than of engineering. And therein lies the presumption that the aspects of design quality that we label objective and those we label subjective are somehow dichotomous. They in fact teeter between objectivity and subjectivity depending on the degree of granularity that observers choose to employ in inspecting not only the artifact but also their own disposition toward satisfaction relative to it.

3. AN ARCHITECTURAL INTERPRETATION OF QUALITY DESIGN

We will never be able to absolutely define design quality because of the relativistic nature of satisfaction in the observer experience. But, our students must still face design choices. So, as IS educators we must provide a framework for them to develop and refine their individual perceptions and understanding of systems quality. The taxonomy of design choice evaluation proposed in Waguespack (2008, 2010c), the 15 *choice properties*, is just such a framework. (See Appendix A.) Choice properties derive from Christopher Alexander's writings on design quality in physical architecture. (Alexander, 2002)

Choice properties address the process of building, the resulting structure, and the behavior of systems as cultural artifacts. Every design decision, choice, contributes to the aggregate observer experience: either positively or negatively. Each choice exhibits the 15 properties with varying strengths or influence that impact the resulting observer satisfaction. The confluence of property strength results from the coincidence of the designer's choice with the collective intention of the stakeholders. The combination of all choices with their respective property strengths results in the overall, perceived design quality. Many of the properties are design characteristics long recognized in software engineering (i.e. modularization, encapsulation, cohesion, etc.). But several reach beyond engineering to explain aesthetics, the art (i.e. correctness, transparency, user friendliness, elegance, etc.). An example of the effectiveness of choice properties in explaining the design quality of production systems is reported in (Waguespack, Schiano & Yates, 2010b).

4. THE ONTOLOGY OF THE RELATIONAL PARADIGM

Illustrating design decisions in the relational paradigm can be a challenge. The idiosyncrasies of data modeling syntax often obscure the intention and/or the result of a design decision. For that reason the learning unit presented here uses a paradigm description independent of programming language, the relational ontology, found in (Waguespack, 2010a) and excerpted in Appendix B. The graphical outline of the ontology is Figure 1 below.

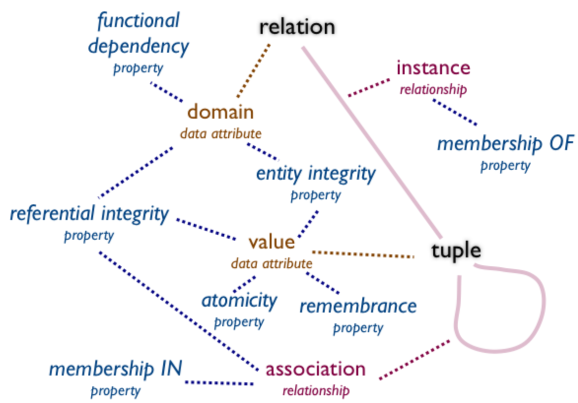

Figure 1 – Relational Ontology

The ontology captures the elements of the relational paradigm eschewing the obfuscation that usually occurs with programming language syntax examples. At the same time an experienced IS teacher can readily translate the ontological elements into a relevant programming or modeling dialect.

5. CRAFTING RELATIONAL MODELING CHOICES THAT STRENGTHEN PROPERTIES OF DESIGN QUALITY

This section, the heart of the learning unit, enumerates the 15 choice properties as defined in Waguespack (2010c) illustrating how modeling choices in the relational ontology can express design quality. In this space-limited discussion one choice property often references another reflecting the confluent nature of the design quality properties as Alexander defines them in physical architecture. (Alexander 2002)

Stepwise Refinement (as the name implies) is an approach to elaboration that presumes a problem should be addressed in stages. The stages may represent degrees of detail or an expanding problem scope. (Birrell and Ould 1988) In either case quality evidence of *stepwise refinement* is demonstrated by the cogent and complete representation of a design element at whatever level of detail or scope is set at each stage. To achieve this representation the modeling paradigm must support abstraction that allows generalization of the scope of interest and then the elaboration of that scope from one stage to the next.

In the *relational* paradigm the choice of *attributes* along with their interdependencies forms entities depicting facts. Each *relation* depicts a cohesive, encapsulated and distinct segment of knowledge. Each instance of that knowledge depends on its distinguishable *identity*: tuple by tuple. The scope of knowledge included in any particular model is constructed by the aggregation of these distinct segments interwoven through their explicit relationships. A whole model is built up stepwise as the "subset of the universe" chosen for the model (its *intension*) is systematically surveyed, cataloged and defined in the collection of *relations*. Each *relation*'s integrity is achieved through its independent *correctness* separate and distinct except for those relations with which is maintains foreign key relationships. But the *correctness* of the whole proceeds from the stepwise assembly of the entire set of *relations* that together describe the reach of a model's responsibilities.

Cohesion is a quality property reflecting a consistent responsibility distribution in a field of system components. (Zuse, 1997) Each *relation* serves a separate, *cohesive* role in the responsibility of representing domain knowledge. *Relations* reflect *identity* as they distinctly capture and represent concepts in the form of facts collected to represent cogent, clearly defined information. The *tuples* within *relations* similarly represent cogent, unambiguously defined instances of reality patterned after the *attribute* structure of their containing *relation* while by virtue of their *entity integrity* they remain distinct from any other *tuple* therein. The population of *tuples* in a *relation* reflects the ebb and flow of experience that the *relation* captures in the dynamics of the represented reality (the *extension*). The *attribute* structure of the *relation* as a template for each of its *tuples* ensures that the experience remains comparable and thus understandable regardless of the number of instances that experience produces. *Functional dependency* and its role in *normalization* assure that each relation represents an unambiguous and atomic division of knowledge in the modeling space. The result is a collection of distinct knowledge experiences bound together by a structure that both explains the significance of each instance and enables the analysis of that experience in terms of the whole reality that the *relation* captures.

Encapsulation is a design quality isolating and insulating instances of domain knowledge. In the *relational* paradigm the individual *relation* assumes the responsibility for capturing and defining the "reality," the "facts," the modeler chooses to instill in a model. The modeler's *intension* is represented in the structure of facts that each of its instances must be able to remember. Each instance of the *relation* remembers by way of the *data attribute value* set in each *tuple*. An important part of the reality captured in each *tuple* is its individuality and the uniqueness of the information that it remembers in its *data attribute values*, its entity integrity. The truthfulness of individual *tuples* can thus be independently established as an *encapsulated* division of "reality." (Scott, 2006) This individuality is determined solely by the values *encapsulated* therein dependent on no other information or relationships as characterized by *Second Normal Form*.

Extensibility is the property of design quality most important in pursuing systems with sustainability essential to cost of ownership economy. Extensibility juxtaposes the potential for new functionality with the effort required to achieve it. (van Vliet, 2008). Although each *relation* (down to the individual *tuple*) represents an independent depiction of reality in a relational model, more complex information is realized and extended through the relationships that associate *relations*. *Associations* permit the depiction of more elaborate descriptions of a model's responsibilities. *Associations* depict correspondence, interdependence or even ownership of concepts between and among *relations*. These *associations* are employed through the *relational operators* that combine or collect facts resident in multiple *relations* and render them correlated, organized and/or extracted as a consistent but distinct representation of knowledge contained in the model.

Modularization along with *cohesion* expresses "divide and conquer" problem solving augmented by the flexibility of configuring and reconfiguring model elements. *Modularization* also supports *scale* permitting the composition of subsystems of varying scope that hold details in abeyance until they require focus. (Baldwin and Clark, 2000) Enlightened module partitioning exposes the solution structure envisioned by the modeler and publishes intentions for further extension by separation of concerns and isolation of *accidents of implementation*. (Brooks, 1987) By the nature of depicting model knowledge in a collection of individual *relations* that knowledge is subdivided and compartmentalized. The process of *normalization* assures that the *intension* depicted by individual *relations* and combinations of *relations* through their *associations* are not ambiguous, redundant or inconsistent. The compartmentalization of knowledge not only affords stakeholders a clearer view of relations individually, but also exposes the opportunities to safely recombine that knowledge through relational operations. This *cohesion* that distinguishes each relation's role in the *intension* of the model also segregates the concerns that accomplish the model's responsibilities and permits attention to be focused on relevant subsets within the overall model's complexity.

Correctness in software engineering is often narrowly defined as computing the desired function. (Pollack, 1982) Thriving Systems Theory frames this property upon two outcomes: 1) validation, the clarity and fidelity of the represented understanding of system characteristics, and 2) verification, the completeness and effectiveness of model feature testing both individually and in composition.

Validation depends on the fidelity of the unfolding process; that through the stages of *stepwise refinement* the "essence" of system characteristics are brought forward maintaining their integrity. (Brooks, 1987) *Modularization* aids in cataloging and focusing on individual essential characteristics. *Correctness* is the only choice property that directly supports itself! *Correctness* must be a priority at each stage as shortcomings grow more and more expensive to rehabilitate as models evolve.

Verification depends on the effective testability of each choice to certify it as "consistent with stakeholder understanding." *Modularization* enables the verification of individual choices or relations. Then relying on the *correctness* of individual relations verification can turn to the certification of relationships resulting from *composition of function*.

Entity integrity, *referential integrity* and *normalization* directly support a relational model's fidelity to the modeler's *intension*. *Entity integrity* assures that the uniqueness of each depiction of reality (*extension*) is enforced by the structure of the relation, *intension*, (the *attribute* set, their respective *data attribute domains* and the respective *functional dependencies*). The specification of that subset of *attributes* that will always contain a unique (combination of) value(s) defines the discriminating characteristics of that knowledge (the *primary key*) – the conformance to which is easily tested and thus protected. *Referential integrity* assures not only that *data attribute values* conform to the *intension* of their *relation's data attribute domain* but, further to the modeled *intension* of *associations* between *tuples* including the ownership relationship between *relations*. *Normalization* extends the assurance of fidelity (model to the modeler's *intension*) by assuring that the interrelationship among *data attribute values* not only supports *entity integrity* and *referential integrity*, but also inhibits the accidental loss of model knowledge (*anomalies*) through the action of *relational operators*.

Transparency is evident structure, revealing how things fit and work together. (Kaisler, 2005) The relational paradigm facilitates *transparency* in two obvious respects. Inspecting the relevant *data attribute values* is sufficient to assess every aspect of integrity whether *entity integrity* or *referential integrity*. These same continuously accessible values form the basis of all relationships among *data attribute values* or among *relations*. The consistency of each and every *data attribute value* can be certified. At any time before or after any and every relational database operation we can verify concurrence with the time independent definition of *intension* given by the *data attribute* set and their respective *data attribute domains* along with the designation of *candidate* and *foreign keys*. There are no implied or hidden definitions of *association* or dependence. Every aspect of *tuple* or *relation* fidelity is discerned through self-evident information. The result of any *relational operator* is determined solely by the *data attribute values* of the *relations* involved.

Composition of Function - As a fundamental tool for managing complexity humans regularly attempt to decompose problems, issues or tasks into parts that either in themselves are sufficiently simple to permit direct solution or can through recursion be subdivided successively until they become sufficiently simple. This is a defining aspect of *modularization*.

Composition of function as a property of design quality is realized in model features that facilitate the extension or retargeting of the model in the future. It is the capacity to combine simple features to build more complicated ones (Meyer, 1988).

Each *relation* in a relational model represents a fundamental aspect of *intension* in the modeler's depiction of reality. *Association* and the use of *relational operators* effect that fundamental *intension* deriving an answer to any query we may invent based on that fundamental knowledge. The result of every *relational operation* is itself a *relation*. The modeler's ingenuity and discipline in forming queries carefully that yield results, *relations*, that are themselves consistent with the integrity constraints of the model creates the potential of an endless cascade of query result as input to another query and so on. This is the direct result of the mathematical formalism upon which the relation model is based – the predominating strength of the relational paradigm. The form in which these queries may be posed to a relational system is constrained only by the choice of mathematical representations (e.g. tuple calculus or domain calculus) or transformations (e.g. relational algebra or relational calculus) to the underlying relational definition.

Identity is at the root of recognition and is another property of design quality not usually defined in software engineering. In the physical world *identity* is literal based upon direct sensorimotor experience: by sight or touch and in some cases by sound or smell – a human experience of the "real" world. In the relational paradigm this human experience is applied directly by collecting those *attributes* that completely describe how any particular instance is unique – the combination of *attributes* that comprise the *primary key*. (Khoshafian and Copeland, 1986) The *primary key* serves to anchor the knowledge that surrounds it – those additional *attributes* that further describe the *tuple* which it uniquely *determines* –those *attribute values* that are *functionally dependent* upon the *primary key*. No *tuple* is permitted to exist in the relational universe (*extension*) unless it has a *primary key – entity integrity*. Ownership as it is manifest through *foreign key associations* is also anchored on the *primary key* of the owner *tuple*.

Scale's affect on design quality is reflected in common idioms: "You can't see the forest for the trees!" and "Let's get a view from 10,000 feet." They reflect the importance of context in recognition and decision-making. *Scale* captures the modeling imperative that all choices must be kept in perspective because it is not sufficient to consider a choice only in the microcosm of itself, as it must also participate in the connectedness of the whole. By achieving scale, a system designer provides differing granularities of comprehensibility to suit the requirements of a variety of observers (Waguespack, 2010).

In many cases the only familiarity that is needed in a relational model is the *intension* – the collection of *relation* definitions with their *attribute* sets defining their respective *attribute domains* and the *associations* among the *relations*. The knowledge structure and semantic relationships that may be mined through *relational operators* sufficiently defines any derivation of information representations that queries may be formulated to elicit. In terms of *scale* any relational model (*intension* or *extension*) may be expanded to incorporate additional knowledge. The modeler achieves this by grafting new knowledge onto existing *relation* structure through the addition and/or alignment of *data attribute domains* and *associations*.

User Friendliness is another property of design quality more often considered aesthetic. It is a combination of: ease of learning; high speed of user task performance; low user error rate; subjective user satisfaction; and, user retention over time (Shneiderman, 1992). Its impact may be easiest to consider in its absence. A modeling choice that is "unfriendly" to stakeholders is confusing, hard to comprehend, unwieldy, and perhaps worst of all, of indeterminate *correctness*. That which defies understanding cannot be determined to be correct. Satisfaction is cumulative. The sensitivity to the stakeholders' conceptions of the essence of the system to be modeled is key to the stakeholders' sense of comfort, familiarity, and expectation.

There is *elegance* in the succinctness and simplicity that arises from properly isolating domain knowledge in the respective *relations*. The use of user/client/customer familiar naming of *relations* and *attributes* and the choice of the commonly used, domain based *attribute values* lends a comfort level to the representation of problem domain experience. The relational model also enables the derivation of contained knowledge at levels of granularity much higher than the individual *tuple* or *relation*. This is because *relational operations* on *relations* produce *relations* as their result. Information derived from a relational database can be presented as if it were simply retrieved from a single physical *relation*. This illusion is easily achieved in relational programming languages that support the definition and storage of queries that may then be referenced themselves as *relations* without the users' notice (*i.e. in ANSI SQL the "create view" syntax*). The facility of such extensions to apply relational operations so discretely creates virtually unlimited opportunities and permits what might otherwise be a complex and daunting algorithm of derivation to be completely ignored by the users.

Patterns describe versatile templates to solve particular problems in many different situations (Gamma et al., 1995). *Patterns* is the property of design quality that channels change (unfolding). A pattern foreshadows where and how change will need to be accounted for. Patterns of the form popularized in (Coplein, 1995) document commonly encountered design questions offering carefully considered advice and cautions.

The most predominant *pattern* found in relational models is the regularity of structure that is embodied in the *tuples* that populates *relations*. This regularity assures that the same "questions" may be posed to each and every instance in a *relation* to elicit a consistently meaningful result. The *tuples* may be readily compared one to another and ordered that their factual content may be exhibited in a useful exposure of multiplicity. At the next level of structure we find the *foreign key* relationship where an *association* between *relations* is constructed by choosing *attributes* in the two *relations* that proceed from the same *attribute domain*. The *pattern* is further emphasized by the property of *referential integrity*. This *pattern* of connecting facts between and among *relations* permits the stepwise assemblage of higher and higher levels of derived information. The *association* enables the traversal of a network of concepts and facts that are both defined by and operationally enabled by the *foreign key* construct. The use of these *patterns* by the relational model designer provides the opportunity to lay out domain knowledge in a predictable and usable mapping.

Programmability in software engineering is often considered a feature rather than a property of design quality – the capability within hardware and software to change; to accept a new set of instructions that alter its behavior (Birrell and Ould, 1988). It is closely allied with *extensibility* and addresses the need for models to welcome the future. What largely separates information systems from other human-made mechanisms is the degree of adaptability that they offer to deal gracefully with change. Unlike most appliances that support a very narrow range of use (albeit with great *reliability*), contemporary information systems are expected to provide not only amplification of effort as in computation, but also amplification of opportunity in terms of different approaches to business or organizational questions. Contemporary information systems are expected to demonstrate that they can reliably accommodate change. As with *extensibility,* successful accommodation of change relies on an understanding of the fundamental options governing the structure and behavior within a particular domain.

What sets *programmability* apart from *extensibility* is a facility that permits altering the systems behavior without having to reconstruct choices – this versatility is not accidental but architectural.

Returning again to the use of *relational operations* to compose higher and higher levels of information we see individual *relations* as building blocks that may be arranged (assembled through *relational operations*) to yield any reasonable arrangement or derivation of information that the underlying *relations* may possess. This is possible because of the individual *identity* that each *relation* fosters in its *tuples* and because of the predictable *reliability* that proceeds from the consistency and safety of *relational operations* that is guaranteed in a set of *normalized relations*. The extent of information mining that may be attempted is limited almost solely by the programmers' imagination.

Reliability is a property of design quality more often associated with implementation than design. It is the assurance that a product will perform its intended function for the required duration within a given environment (Pham, 2000).

There is an overarching simplicity that results from the fact that all of the properties of integrity are based upon *data attribute values* that may be readily inspected before or after any *relational operation*. *Intension* is expressed in modeled expressions of integrity constraints that are domain specific. The synchronization between the *intension* and *extension* of the model is easily tested because of this simple *transparency*. *Reliability* is assured if valid *relational operations* are applied consistent with model integrity constraints and thus will always yield consistent ("truthful") information.

Reliability in design reflects an austerity that confines design elements to the essentials of the stakeholder's intentions. When design or implementation decisions involve additional constructs due to technology or compatibility, these *accidents of implementation* must be clearly delineated so as not to imply that they are essence rather than accident. This clear distinction will protect future system evolution from mistaking accidental "baggage" as stakeholder intentions.

Elegance is perhaps the epitome of subjective quality assessment that clearly sets choice properties of design quality apart from traditional software engineering metrics. "Pleasing grace and style in appearance or manner," that's how the dictionary expresses the meaning of "elegance." (Oxford English Dictionary)

> "A designer knows he has achieved perfection not when there is nothing left to add, but when there is nothing left to take away." (Raymond, 1996)

Models composed of choices that are consistent, clear, concise, coherent, cogent, and transparently correct exude *elegance* and nurture cooperation, constructive criticism and stakeholder community confidence. These are models that confess to their own shortcomings because their clarity obscures nothing, even omissions. These are models that satisfy stakeholders. They appear "intuitively obvious."

Elegance is achieved largely through the relational model when *relations* are modeled with a minimum of extraneous or redundant information. Indeed eliminating redundancy is common mantra of relational modeling. The laying out of basic facts divided into distinct *encapsulated* containers of knowledge and the subsequent composition of higher levels of derived information effects a sense of economy of form and abundant opportunity for exploring and extracting the knowledge that a database so fashioned accommodates.

Elegance largely proceeds from the efficient and effective representation of *essential* system characteristics along with those features emerging out of design decisions, *accidents of implementation*, that are laid out with equal clarity for separate consideration. This is the *field effect* of the beneficial, integrated, mutual support of strong choices described in Thriving Systems Theory. (Waguespack, 2010c)

6. INTEGRATING THE DESIGN QUALITY LEARNING UNIT IN A RELATIONAL MODELING SYLLABUS

The design quality discussion provides a quality vocabulary for one-on-one consultations between teacher and student as each develops their relational models. In this one-on-one context each student's specific design decisions may be discussed and evaluated in relationship to the design quality properties, an opportunity for individualized, reinforced learning and/or suggested improvements.

The deeper subtleties of design quality present a challenge for some students particularly in a compressed format. The "light doesn't go on" right away for all students. However, the integration of the ontology and design quality property based vocabulary establishes a touchstone that returning students report helps them "to name" the "quality elements" they rediscover in succeeding coursework and professional practice.

In your own curricular situation the distribution of learning unit elements may span more than one course (some addressed in database programming, requirements engineering, or database design, etc.), be rearranged to suit your modeling tools, or be adjusted to your course sequencing with context-appropriate examples. Regardless, the learning unit components are flexible and robust enough to suit various specific program needs.

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Appendix A – Choice Properties (Waguespack 2010c)

	Choice Property	Modeling Action	Practical Action Definition
1	Stepwise Refinement	elaborate	develop or present (a theory, policy or system) in detail
2	Cohesion	factor	express as a product of factors
3	Encapsulation	encapsulate	enclose the essential features of something succinctly by a protective coating or membrane
4	Extensibility	extend	render something capable of expansion in scope, effect or meaning
5	Modularization	modularize	employing or involving a module or modules as the basis of design or construction
6	Correctness	align	put (things) into correct or appropriate relative positions
7	Transparency	expose	reveal the presence of (a quality or feeling)
8	Composition of Function	assemble	fit together the separate component parts of (a machine or other object)
9	Identity	identify	establish or indicate who or what (someone or something) is
10	Scale	focus	(of a person or their eyes) adapt to the prevailing level of light [abstraction] and become able to see clearly
11	User Friendliness	accommodate	fit in with the wishes or needs of
12	Patterns	pattern	give a regular or intelligible form to
13	Programmability	generalize	make or become more widely or generally applicable
14	Reliability	normalize	make something more normal, which typically means conforming to some regularity or rule
15	Elegance	coordinate	bring the different elements of (a complex activity or organization) into a relationship that is efficient or harmonious

Appendix B - Relational Green Card (Waguespack 2010a)

The Relational Paradigm

Without a Language or Syntax!

What is the relational world all about?

The Relational Ontology

This ontology is consistent with the practice in computer science and information science categorizing a domain of concepts (i.e. individuals, attributes, classes and relationships). This ontology of the relational paradigm of data modeling minimizes the vestiges of implementation languages and methodologies to expose the core nature of relational concepts.

1. Individuals

The most concrete concept in the relational paradigm is the ***tuple***.

1.1. Tuple

A *tuple* corresponds 1-1 with a single concept of reality that it represents. A *tuple* collects the facts that identify it as a single concept and the facts most closely identified with it.

2. Attributes

Attributes are those characteristics (facts) that describe a *tuple*. In the relational paradigm *attributes* define data characteristics - each of which has a static and dynamic form. A prescribed set of *attributes* defines what is called the ***structure*** of a *tuple*. From inception to extinction the *structure* of a *tuple* is immutable. The number of *attributes* in a *tuple* is called its ***degree***.

2.1. Data Attribute

Data attributes store information (data) in the *tuple* and implement the property of ***remembrance***. *Remembrance* is manifest in each *attribute* dynamically as "what *is* remembered," a particular ***data attribute value*** for each *tuple* derived from a ***data attribute domain*** that statically defines "what *can* be remembered," the possible values of the *attribute*.

3. Classes

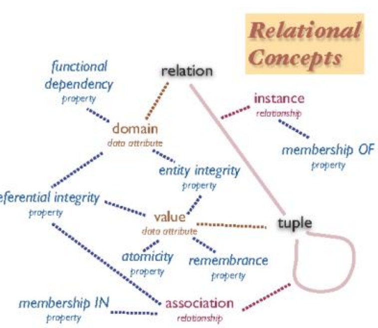
The relational paradigm groups individuals into a collection called a ***relation***. The *relation* corresponds directly with its mathematical antecedent where *attribute* values within each *tuple* reflect a correspondence with the coincidence of facts in the "real world," a correspondence (*attribute* relationship) that is shared by every *tuple* in that *relation*.

3.1. Relation

The ***relation*** concept combines both a definition of *structure* and the collection of *tuple(s)* based on that *structure*. A *relation* is defined as a fixed set of *data attributes*. Every *tuple* is an ***instance*** of a specific *relation* and shares the same static *structure* defined by that *relation* with every other *tuple* of that *relation*. The *relation* concept thereby fuses the existence of the *tuples* to that of their *relation*; *tuples* cannot exist independent of their defining *relation*. *Tuples* are said to be ***members of*** their *relation*. *Tuples* are added to or deleted from their *relation*. The order of attributes in a *relation* is insignificant except that the order is consistent for all *tuples*. *A relation* is also commonly called a ***table*** and each of its *instances*, a ***row***. The collection of every *data attribute value(s)* for a particular *data attribute* in a *table* is called a ***column***.

4. Relationships

Relationships in the *relational* paradigm are based on the property of *remembrance* and the juxtaposition of *data attribute values* in one or more tuples in the same or across *relations*.



4.1. Behavioral Relationships

The behavioral relationships are all based upon the *data attribute value(s)* and which values are permitted to coexist in and across *tuples* and *relations*.

4.1.1. Functional Dependency

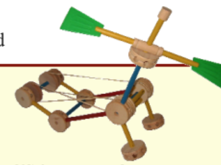
In a *relation* a *data attribute* is ***functionally dependent*** when its *data attribute value* is always the same in any *tuple* for a given value in a second *data attribute*. In other words, the value of the first *data attribute* ***is determined by*** the value of the second (called the ***determinant***). *Functional dependency* expresses the informational integrity of *relations*.

4.1.1.1. Entity Integrity

Entity integrity defines the two-fold quality of *tuple* uniqueness in a *relation*: a) every *tuple* in a *relation* is distinct in some *data attribute* *value(s)* from every other *tuple* in that *relation* or symmetrically, b) there is a designated subset of *data attributes* (*column(s)*) called the ***primary key*** such that the *data attribute value(s)* in that *relation* is distinct for all *tuples* and no values may be ***null*** (a value which is unknown and incomparable to any other value). There may be more than one subset of *data attributes* with the value characteristics of the *primary key* (each called a ***candidate key***) but only one is designated as the *primary key*.

4.1.2. Association

An ***association*** is a relationship between *tuples* in the same or different *relations*. *Tuples* are intrinsically separable by way of *entity integrity*. At the same time, humans are compelled to categorize their experience of things in the physical world by superimposing groupings that collect *tuples* into sets. *Tuples* become members in a group based upon *data attribute value(s)*. This property is called ***membership IN***. This property also permits humans to identify a *tuple* that is not in a set (i.e. discrimination). (*Membership IN an association is distinct from membership OF a relation which is intrinsic by way of instance relationship.*)



Without syntax?

Every *language* that is invented to express concepts carries with it the understanding and the biases of the inventor. Depending on his/her purpose(s) those biases simplify certain tasks performed with the language but may obscure the underlying concepts.

Programming language design must deal with the feasibility of automated translation and interoperability with other programming languages and operating systems. Compromises and assumptions are chosen to make the resulting language efficient, effective and marketable.

The goal of this description of the entity-relationship paradigm is to succinctly make the concepts understandable - an ambitious task to say the least!

- Professor Waguespack

4.1.2.1. Relational Operations

Membership IN is realized through **relational operations** keying on relation structure and values. Each relational operation produces a real or virtual relation as its result. The **selection** operation retrieves *tuple*(s) based upon a **selection predicate** testing data attribute value(s) to determine whether each *tuple* is or is not in the set. Selection predicates are based on any boolean comparison including constant values or values referenced in *data attribute value(s)*. The **projection** operation copies all the *data attribute value(s)* for a particular *column(s)*.

Association between *relations* (or a *relation* and itself) is based upon relating (matching) *data attribute values* in *tuples* of one *relation* with those of another. The ***join*** operation pairs every combination of *tuples* from one *relation* with those of another *relation* and copies the *data attribute values* from the pairs where the pairing satisfies a *selection predicate*. This *relational operation* is called *join* because facts from two sources are joined in the result.

4.1.2.2. Join Compatibility

Join compatibility requires that the values involved in comparisons (i.e. *selection predicates*) whether constants or *data attribute values* derive from the same *data attribute domain*.

4.1.2.3. Referential Integrity

When *relations* are devised such that a *tuple* in one *relation* predisposes the existence of (***owns***) *tuple(s)* in another, the *data attribute(s)* of the second required to *join* the *relations* is called a ***foreign key***. Referential integrity asserts that any value found in the *data value attribute(s)* of a *foreign key* must appear in a *tuple* of the first *relation* as the value of a *candidate key* or itself be *null*.

4.1.3. Normalization

Relational model consistency depends on the semantic concurrence of the behavioral relationships and the objectives of the database modeler, the ***intension,*** (rather than the accident of a *relation's* contents at any particular instant, its ***extension***). The integrity properties defined above enable the database modeler to devise a structure and behavior of *relations* that avoid semantic discord called ***anomalies***, the unintended loss or modification of information by relational operations. *Relations* designed to avoid certain kinds of *anomalies* are said to be ***normalized*** or in ***normal form***. ***Normalization*** is the arrangement of *data attributes* and their relationships among *relation* structures to prevent particular *anomalies*.

4.1.3.1. First Normal Form

First Normal Form asserts that every *data attribute value* is ***atomic***, indivisible in value or form and may not be operated upon except as a whole and single value.

4.1.3.2. Second Normal Form

Second Normal Form is first normal form and asserts that every *data attribute value* not in the primary key is ***fully functionally dependent*** upon the *primary key*. ("Fully" means applying to every *data attribute* of the *primary key*.)

4.1.3.3. Third Normal Form

Third Normal Form presupposes first and second normal forms and asserts that no *data attribute* outside the *primary key* is ***transitively dependent*** upon the *primary key*. ("Transitively" means an attribute(s) *functionally dependent* upon an attribute *functionally dependent* upon an attribute (. . .) *functionally dependent* on the *primary key*.)

Lessons Learned: The Evolution of an Undergraduate Research Program

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Abstract

Undergraduate research programs are commonplace at many universities. However, little research has been conducted to evaluate their ongoing and long-term effectiveness from the standpoint of the undergraduate student researcher. In an effort to gain perspective from the student researcher, including their thoughts on such a program, a survey was conducted of past participants of a business school research program which brings together three stakeholders in the research process: a faculty member, a business executive mentor, and the undergraduate student researcher. The results presented highlight the major benefits and deficiencies of the existing program from the student's perspective and provide an evaluation of the program's overall effectiveness. In addition, our findings are compared to the results of a similar survey, performed fifteen years earlier, of the same undergraduate research program. The comparison reveals a maturation of a program which has evolved to better support the financial needs and time demands of today's students.

Keywords: undergraduate research, student engagement, academic theory, mentor

1. INTRODUCTION

The cost and relative importance of attaining an undergraduate degree in today's economy continue to rise. Students and institutions have recognized that a quality education is essential to meet market demands. A growing movement to improve the undergraduate educational experience is the offering of undergraduate research opportunities. (Boyer Commission on Education Undergraduates in the Research University, 1998 & AAC&U 2002 Report) Such valuable opportunities provide students with deepened learning experiences enabling them to further develop skills desired by both employers and graduate schools.

The literature has shown that undergraduate research increases student engagement (NSSE 2010), fosters the development of new skills (Lopatto, 2003 & Lopatto, 2006), enhances academic or professional credentials (Lopatto, 2003), and helps develop collegial working relationships with faculty research mentors (Lopatto, 2003 & Seymour, Hunter & Laursen, 2004).

Student engagement in learning is a key element to improving the quality of education attained. Engaged students move beyond passive receivers of information to critical thinkers capable of analyzing complex issues and generating new knowledge. In addition, students gain or refine the following skills: improved presentation, writing, research, communication, and relational (Tan 2007, Loppato 2003, & Seymour, Hunter & Laursen, 2004). The 2010 results from the National Survey of Student Engagement support this as they find undergraduate research is a high-impact engagement practice among students. (NSSE 2010)

Skills acquired through a research experience ultimately enhance a student's academic or professional credentials, regardless of the path a student plans to follow after graduation. For graduates looking to enter the workforce, employers may substitute a rigorous research experience for years of practical experience (Hoffman, 2009). For students interested in pursuing a graduate degree, a successful undergraduate research experience demonstrates the essential skills graduate admissions committees look for in prospective candidates.

The personal experiences can be fruitful and lasting as well. Students often cite the development of collegial working relationships with faculty mentors as a benefit of undergraduate research (Seymour, Hunter & Laursen, 2004). They value the shift from a distinct professor and student relationship to one of partners working toward a common goal. A primary benefit of this relationship is acquiring guidance and knowledge of an expert in their field of interest. In addition, this transition also facilitates an environment where students often feel comfortable reaching out to their mentors for personal and career guidance. This relationship frequently continues long after graduation (Seymour, Hunter & Laursen, 2004).

In this paper, we present a business college's funded undergraduate research program and the findings from a survey of its student researchers who participated and completed the program within the last ten years. The results highlight the strengths and weaknesses of the program and provide a window into the program's overall effectiveness. In addition, our findings are compared to the results of a similar survey of the same undergraduate research program from 1996. Our findings ultimately suggest that the program has matured over time. We provide recommendations for this and other undergraduate research programs to support their growth and maturation.

2. THE UNDERGRADUATE RESEARCH PROGRAM

The motivation for the undergraduate research program at Xavier University was derived from an existing program at the University of Alabama (O'Clock & Rooney, 1996). The idea was to pair undergraduate student researchers with faculty and business executives on a manageable research project with the intention of creating a written piece which could be presented at an academic conference and/or submitted to a peer-reviewed academic journal. The student's role was to be many fold. This could include work in the area of literature review, survey generation, statistical methodology and application, technical writing, and presentation.

While teacher scholar research models have many existing applications, the teacher, mentor, and scholar model was a novel idea.

The Downing Program (Prior to 2002)

The Jack and Mary C. Downing Teacher/Scholar/Mentor Program at Xavier University in Cincinnati, OH, was established in 1987 in its Williams College of Business (COB) with the goal of providing talented business students an opportunity to engage directly in research projects with faculty members, in their specific disciplines, and business executives from the local business community.

Originally, the length of the Downing Program for each project was two consecutive semesters. The program was available to full-time business students who had completed their sophomore year of study, declared their major in business, and at least one year of course work remaining. A selection committee of business school faculty maintained responsibility for student selection to the program. This committee was comprised of representatives from all departments in the COB as to not bias the selection by department. Selection took place in the fall semester and awarded students began their research projects the following spring semester. In addition to common student academic transcripts, students applicants were required to provide a list of their extracurricular activities, past and current employment, three letters of reference, and a two-page essay outlining their academic and professional interests. If selected as a Downing Scholar, a student would receive a tuition reduction scholarship of $1,500 per semester of participation. In exchange, the student was expected to work 12 hours per week with their assigned faculty mentor. A student would also be assigned to an executive mentor in the business community by the COB and would be required to meet them, on an informal basis, several times over the course of their project. (O'Clock & Rooney, 1996)

Faculty mentors for this program were chosen by the same selection committee of business school faculty. Their selection was based on specific research proposals, agendas, and project budgets. Full time, tenured or tenured track faculty members of the business school were eligible to apply. Faculty selected for the Downing Program were awarded a small stipend per semester for use toward scholarly activities associated with the research project. The faculty member was then matched, by the selection committee, to a selected student researcher. Students and faculty were matched by the committee based on stated academic and research interests and were not required to be studying and teaching in the same department (O'Clock & Rooney, 1996).

Ultimately, the faculty member was expected to help the Downing Scholar develop an understanding of the research process and its role in the academic environment, promote new research, and aid students in improving critical thinking skills, ability to analyze data, and understanding how knowledge is constructed.

A final summary of the project and findings, budget and any generated papers were to be submitted to the selection committee at the conclusion of the year long project.

The Downing Program Today

The Downing Scholarship Program has evolved to meet the changing needs of the students, faculty, and business environment. While the purpose and many of the details of the program are the same as previously described, three substantive changes to the Downing Program occurred in the year 2002.

The first was to student and executive pairings. At the inception of the program, a Downing Scholar was assigned to a specific executive from the local business community for the duration of the project. Since that time, in an effort to initiate professional networking and career connections for all business students, the COB implemented a college-wide executive mentoring program. Therefore, the general executive mentor assigned within the COB replaced a Downing specific mentor. As such, executive mentors are no longer specifically assigned to projects. This change shifted the regular interactions with the business mentor to occasional interactions with no specific research goals or shared interests required. This, in effect, has reduced the program to a general teacher scholar research model. See Gardner et al. 2010 for a thorough discussion on the teacher scholar model.

The second change involved project duration. Originally, the Downing Program consisted of two semesters of research. It was found that this period of time was insufficient to adequately meet the requirements of most projects. Downing Scholars now have three semesters to complete their research projects.

The third and final change made to the program was to student funding. Compensation for students increased from $1,500 per semester to $2,000 per semester. Coupled with the increase in project duration, the total award increased from $3,000 to $6,000. Students were also given the option of receiving a portion of the award as taxable income, rather than assign the entire award to scholarship.

3. PARTICIPANT RESPONSES

As part of a larger project to assist the Downing Program selection committee in their selection process, a survey was conducted in fall 2010 of participants in the Downing Program who completed projects since the program's 2002 enhancement. This effort was the first external evaluation of the program since 1994 and only the second in its 23 years of existence. The intention of the survey was to gain insight into the effectiveness of the program, areas in need of improvement, and outcomes resulting from the projects.

The first part of the survey asked respondents to indicate their level of agreement with statements about the program based on a seven point Likert scale ranging from strongly disagree to strongly agree. The items available to respondents were repeated from the 1994 survey as to provide insight into the state of the Downing program and its maturation. Mean responses from the 1994 survey (n=15) are compared to mean responses to the 2010 survey (n=15) in Figure 1. Only historic average data was available from the 1994 survey.

In addition, the student researchers were asked about the resulting research deliverables and their outlets for publication. The results are found in Figure 2.

Also, in an effort to better understand respondent sentiment, several open-ended questions were included in the 2010 survey. They were as follows:

- Please briefly describe the most significant/most memorable aspect of your Downing experience.
- What were your incentives for becoming involved in the Downing program?
- What do you perceive to be the benefits of your participation in the Downing program?
- What do you perceive to be the weaknesses or shortcomings of the program?

4. EVALUATION OF THE PROGRAM

A telling sign of a vibrant undergraduate research program is the willingness of prior participants to repeat the experience (Alexander B., Foertsch J., Daffinrud S., Tapiar R., 1997). This establishes a positive perception of the program for future potential participants. For this study, nearly all students surveyed in 2010 strongly agreed that they would repeat the experience. In comparison to the 1994 survey, there was a slight improvement ($\mu_{1994} = 6.7$ vs. $\mu_{2010} = 6.8$) in the 2010 results for the mean level of agreement.

When openly queried about the benefits of the program, past participants indicated two aspects which stood out as consistent drivers of this positive perception of the program: acquisition of new knowledge and mentoring relationships. These support the findings of Lopatto (2003).

Interestingly, a majority of respondents listed gaining new knowledge as an incentive for application. The responses varied from "an interest in gaining research experience" to "learning skills not taught in the classroom". Thus, the incentive was proven valid as acquisition of new knowledge was a primary factor contributing to an overall positive perception of the program. Some of the supporting responses were specific to learning about the research process, while others were more general in nature, such as "exposure to new ideas" or "learning outside the classroom."

The development of relationships with mentors is a well established benefit of undergraduate research. This aspect did not initially appear as transparent to the students as an incentive to participate as only three of the respondents stated it was a relevant factor. Yet, more students stated faculty mentoring was the most significant memory/memorable aspect of their Downing experience than any other response. As one student stated "The most memorable part was working closely with a faculty member, specifically in my major." This is supported in the 2010 survey where respondents were asked whether the level of interaction with their professor met their expectations. The majority of respondents either moderately agreed or strongly agreed. In comparison to the results from the last survey, there was a decrease in mean degree of agreement in response to whether the level of interaction met their expectations. ($\mu_{1994} = 6.1$ vs. $\mu_{2010} = 5.8$) This decrease may be the result of the loss of interaction with an executive mentor which required an increased level of interaction with faculty. Given the level of agreement, these results support the idea that interaction with their professors is a key element in their positive experiences with the program.

In general, the previous were non-monetary benefits of the program. So, to validate the comprehensive view of such benefits, respondents were asked to gauge the overall sufficiency of these benefits. The results of the survey show that the non-monetary benefits have impacted the students. Mean agreement of the benefits of the non-monetary rewards of the program remain unchanged from 1994 to 2010 (6.2)

Financial reward, in light of the cost of education today, is also a clear driver for the success of this program. Due to the increased amount and change in form of payment to the students, the increase in mean degree of agreement (μ_{1994} = 6.1 vs. μ_{2010} = 6.5) validates the changes made in 2002. When asked to describe their incentives for becoming involved in the program, the majority of respondents listed monetary rewards as a primary reason for participation. Thus, providing adequate financial reward is important for students who are considering applying for this program. However, after the experience, few mention financial reward as a benefit of the program.

Another benefit of the program changes made in 2002 is the increased program length. In 1994, participant sentiment was extremely low (μ_{1994} = 2.7) as it pertained to the length of the program. However, with the 50% increase in duration, the respondents' mean nearly doubled (μ_{2010} = 5.3). Again, this provides a solid incentive for future participants in the program.

Last, as it pertains to the research process, theory, and practice, the results are somewhat troubling. When queried about a heightened awareness of the research practice, participants in the 2010 survey revealed a reduction in the mean response (μ_{1994} = 6.2 vs. μ_{2010} = 6.0). as compared to the 1994. A similar reduction was experienced when respondents were queried about their project's merging of theory and practice (μ_{1994} = 6.0 vs. μ_{2010} = 5.3). However, students were creating publishable and presentable work. There was a large increase in the number of academic conference presentations, but the number of actual publications was halved.

Interestingly, past participants made no mention of the executive mentor in any of their comments on the 2010 survey. Therefore, we must conclude that the executive mentor contribution is no longer significant to the project but rather to the student as a career mentor.

5. RECOMMENDATIONS TO THE CURRENT PROGRAM

Overall, it appears that several aspects of the program have led to a positive perception of the program from past participants. A financial incentive helps attract students to the program along with potential mentoring relationships and acquisition of new knowledge, the latter two are components participants indicated made the experience memorable and worth repeating. However, there are some shortcomings in the program. Based on the results of the survey, the primary weaknesses and shortcomings noted about the program relate to the student work structure. As stated by one respondent "… enjoyed the freedom given in this program to set your own standards and goals…. But, I would have liked to have had specific requirements or guidelines that I was working toward." Improving the work structure in the following three areas should help to improve the overall effectiveness of the program: an introduction to research methods seminar, establishing a forum for showcasing work in-process and completed work, and more consistent interaction with the faculty partner.

The first recommendation for the program is to create a multiple session seminar to introduce students to research methods. Current faculty in the COB could present their ongoing and complete research and discuss the methods they employed with the student scholars. Since a substantive portion of the student research involves literature review, university librarians could also participate and introduce strategies and techniques for using university resources. Such a program could help students gain perspective on the rigors of academic research and see the integration of theory and practice.

The second recommendation for the program is to increase the recognition of work completed at informal public presentations in the COB at the completion of each semester. The presentations would offer an opportunity to showcase student and faculty contributions to other current scholars and members of the academic community at large. The scheduled events would help motivate students to complete team research goals and give them the opportunity to field outside comments and suggestions. In fact, Kinkead (2003) found that "For many students and faculty, the act of research and its resulting product is reward enough; however, public recognition is important".

The final recommendation concerns the interaction of faculty and student researchers. The 2010 survey included a simple question that asked past participants the amount of time they spent working with their assigned faculty member. In response to this, 80% indicated that they spent 0-2 hours a week and 20% stated they spent 3-5 hours. This falls far below the recommended 12 hours of interaction. We suggest that students and their professors be expected to meet at a designated time and place regularly, much like other classes in a student's schedule, with required tangible outputs to be presented at the end of each semester. This could also provide the professor mentors greater opportunity for improved communication of the research process as a whole and continue the lessons of the research seminars. The output requirements and consistent meetings would help improve two aspects of the program where the survey revealed a decrease in mean agreement since the last survey: appropriate level of interaction with the professor and awareness of the research process.

We would also suggest that the program examine the role of the executive mentor. It is clear that the executive mentor no longer plays an active role in the program. As such, the mission of the program is not completely being met. The selection committee should address the ongoing need for an executive mentor.

6. RECOMMENDATIONS TO OTHER PROGRAMS

We would also like to make several recommendations to current and proposed undergraduate research programs at other universities. They are drawn from the current positive and proposed changes to the current COB program. The recommendations are as follows:

- Work diligently to match students to faculty with similar research interests
- Provide at least 3 academic semesters for the program
- Provide adequate financial incentives to candidates that can be drawn in part as scholarship and in part as taxable income
- Encourage faculty and student mentoring through engagement events
- Create a short seminar series to introduce students to general research methodologies
- Create a series of research presentations each semester to showcase the undergraduate research being performed
- Establish regularly scheduled meetings with faculty and student researchers to keep students engaged in the research and on track
- Strongly encourage that all works either be presented at conferences or submitted for publication (rewards should be considered for those papers accepted for either).

7. CONCLUSION

Today's students are constantly looking for ways to stand out from the crowd as they migrate towards employment or graduate school. One area that continues to grow and provides such an opportunity is undergraduate research. In this paper, we describe and benchmark the evolution of a business college's undergraduate research program from its original form to its current form. Past participants of the current research program were surveyed and their results were compared to those from participants in the old program drawn from a similar study performed 16 years earlier. Through comparison, we found the program to be evolving and vibrant. However, it was not without it failings. While financial incentives and rewarding mentoring experiences were shown to be strengths, students did not feel as strongly about their gained research skills and the overall work structure of the program. Based on our findings, we were able to make recommendations to the current program to better equip it to thrive and positively evolve. These recommendations along with the positive aspects of the current program provide solid advice for existing or proposed programs.

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Appendices

Figure 1: The State of the Downing Program

Question	1994 μ response	2010 μ response	% Change
My involvement in the Downing program provided me with sufficient monetary/economic rewards.	6.1	6.5	6.56%
My involvement in the Downing program provided me with sufficient non-monetary rewards.	6.2	6.2	0.00%
My involvement with the Downing program made me more aware of the research process and its role in the academic environment.	6.2	6	-3.23%
The project we worked on involved a merging of academic theory and practice.	6	5.3	-11.67%
The level of interaction with the professor met my expectations.	6.1	5.8	-4.92%
The program's time frame was sufficient.	2.7	5.3	96.30%
In hindsight, if given the opportunity, I would certainly participate in the Downing program again.	6.7	6.8	1.49%

Figure 2: Research Deliverables

Question	1994 Yes responses	2010 Yes responses
Did the research lead to a publication of an academic paper/article?	4	2
Was the research presented at an academic conference? (published as proceedings)	2	7

A Collaborative Capstone to Develop a Mobile Hospital Clinic Application Through a Student Team Competition

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Abstract

A new collaborative capstone model is presented that consists of three synergistic elements: 1) a capstone course component, 2) a business component, and 3) an advanced technical course component geared towards enhancing the student capstone learning experience. The model was fully implemented at Bentley University in spring 2012 with collaboration among a software project management capstone course, a research and teaching hospital, and a mobile application development course. The capstone project was structured as a student team competition to create the best mobile wayfinding application for patients and employees of Massachusetts General Hospital's clinic and labs. The collaborative capstone teaching methods leading to the successful student team outcomes are presented along with success factors and lessons learned.

Keywords: CIS capstone model, capstone course, collaborative capstone, course collaboration, real world project, team project competition, software project management, mobile application development, Android OS, open source development environment

1. INTRODUCTION

An innovative computer information systems (CIS) capstone model is presented that consists of collaboration among an applied software project management capstone course; an advanced technology course — in this case, a course in mobile development; and an external business organization: a hospital with a suitable project need. This capstone model 1) accommodates the widely diverse backgrounds of computer information systems (CIS) students, 2) provides students with experience in project management and software development life cycles as well as exposure to leading-edge technology, 3) includes a real world, creative mobile development project and 4) demonstrates the students' capability in mobile computing. The capstone project is designed as a competition among student teams.

The capstone collaboration between two computer information systems courses at Bentley University and with Massachusetts General Hospital arose as a creative solution to a convergence of different circumstances. A researcher and staff physician at Massachusetts General Hospital (MGH) working with Bentley University faculty proposed that students write a cell phone application that would help patients and employees find their way around one of the hospital's clinics. Bentley University's CIS capstone course, Applied Software Project Management, appeared to be a logical selection to create such an application. A challenge that the capstone course faced was the short amount of time — a single semester — to execute the project management processes, learn the necessary technology for the project and create the application.

A different set of challenges faced the final semester, senior-level Android mobile development course. Student teams have a limited time to brainstorm and develop a complex, real-world project that demonstrates their mobile development capabilities to the instructors, clients, and future prospective employers.

A synthesis between the two courses was developed to reap benefits for all of the students involved. Development teams consisted of students from the two courses. The course syllabi were coordinated so students would have the required mobile technology background prior to submission of project deliverables. The format of the term project was a competition where the team who created the best application would be invited by the MGH research scientist to present their work for consideration of an expanded hospital mobile wayfinding project.

Although trial runs of individual components of the collaborative capstone model were implemented earlier, the entire model was first fully implemented in spring 2012. The first trial run, which took place in spring 2011, involved a single team with students from both classes to create a proof-of-concept Android application prototype. The second trial run in fall 2011 introduced the competitive component by having the student teams develop the best mobile web prototype. Only in spring 2012 was the course syllabi coordinated and the Android application developed for the hospital clinic and labs.

2. RELATED WORK

Collaborations between capstone courses and real-world business clients enhance students' learning by relating course concepts directly to the creation of an application that will be used by the client (Tenenberg, 2010), increasing students' motivation and performance (Grant, Malloy, Murphy, Foreman, & Robinson, 2010; Kangning, Siow, & Burley, 2007; Pauca & Guy, 2012; Reinicke & Janicki, 2010; Rusu, Rusu, Docimo, Santiago, & Paglione, 2009; Tenenberg, 2010), improving communication skills (Grant, et al., 2010; Tappert & Stix, 2012), and improving creative problem solving skills (Reinicke & Janicki, 2010). Real world projects increase job market desirability by providing students with actual work experience that can be added to their resumes and discussed in job interviews (Grant, et al., 2010; Schwieger & Surendran, 2010) along with marketable skills (Scott, 2006) thus making them better prepared for the industry (Mohan, Chenoweth, & Bohner, 2012). The hospital wayfinding project in our study was undertaken with the knowledge that previous capstone projects involving the health care industry had been successful (Pauca & Guy, 2012; Scott, 2006; Tappert & Stix, 2012). Real world capstone projects have also produced successful applications for companies (Scott, 2006), governments (Grant, et al., 2010; Tappert & Stix, 2012), and non-profit organizations (Hashemi & Kellersberger, 2009; Scott, 2006).

Cross-course capstone collaborations have typically entailed students taking two courses sequentially and implementing a software project over the course of an academic year (Grant, et al., 2010; Reinicke, Janicki, Thomas N.). However, cross-course collaborations, consisting of students from two different classes offered in the same semester, can provide students with valuable real world experience of working on a single software development project that is comprised of two or more sub-teams working in concert (Rusu, et al., 2009; Schwieger & Surendran, 2010; Tabrizi, Collins, & Kalamkar, 2009). In two prior studies, cross-course collaborations involved teams comprised of students from two different universities where the client was local to one university but geographically remote to the other university (Rusu, et al., 2009; Tabrizi, et al., 2009). The inequity in client access resulted in local sub-teams representing the entire group in one case (Rusu, et al., 2009) and the client company assuming the project manager role in the other case (Tabrizi, et al., 2009). Neither of these two studies involved a capstone course. The first case included graduate students taking a software design Methods course and undergraduates enrolled in a Software Engineering I course. The second case had a mixture of juniors and seniors taking software engineering courses. The proposed collaborative model differs in that one of the participating courses is a capstone, students from both courses are from the same university, all students are local to the client, and the sub-teams interact as equals.

Mobile application development, the technical component of the collaboration capstone model, meshes well with the real-world business component of the model because it permits students to easily and inexpensively publish their real world applications through online, mobile application stores (Pauca & Guy, 2012), and provides students with mobile computing skills in demand by the information systems industry (Riley, 2012). The capstone course experience is enhanced by the addition of mobile application development by increasing the excitement of students (Dickson, 2012; Riley, 2012) because the applications developed have a direct tactile user interface — students can "touch" their creations — rather than an indirect user interface that controls an application through the use of a mouse and keyboard. Although a great deal of pedagogical research has begun to be published on the use of mobile computing in programming courses (Kurkovsky, 2009; Loveland, 2011; Roy, 2012; Wolber, 2011), pedagogical research on mobile development capstone courses has been sparse (Pauca & Guy, 2012).

3. BACKGROUND

Bentley University is a business university where all undergraduate students are required to take nine business core courses. All CIS students are also required to take introductory Java, database, and basic architecture and networking courses. Beyond the minimum required of all CIS majors, students can choose to concentrate their efforts on software development, systems analysis and design, software project management, systems administration, or networking. Many students take additional courses in Web development, advanced database development, multi-tiered architectures and/or mobile application development. As a result, the elective CIS capstone course — CS460 Applied Software Project Management — has customarily been tailored to support students with a wide range of technical and managerial abilities. Students gain real world experience by working for a client on complex application development projects. Concepts covered in the course — which include software development life cycles, group dynamics, project management tools and techniques, software quality management, and risk management — are applied by the student teams in the execution and completion of their term projects. In addition to the wayfinding application, previous course projects have included an organ transplant matching simulator, a parked car locator, a friend tracking and directional system, and a medical resource locator and alert system. The development environments and technologies are determined by the students and previous applications have run on the World Wide Web, Windows, and/or Android cell phones.

CS402 Advanced Computing Topics is a course that, for the past two years, has focused on application development for Google's Android OS. Students learn to build applications for a real-time, mobile computing platform. The course emphasizes development techniques utilizing application components, XML based user interfaces, Google Maps, animation, multithreading, and SQLite (see Appendix A). By the end of the semester, students are capable of developing mobile applications of real world utility. Acceptance into the elective course requires two semesters of Java programming and a semester of database development that includes SQL programming. The course grade is based on six individual homework assignments and a team project in which each team develops an Android application meeting a specific set of technical requirements.

The collaboration between the two elective courses was structured to be flexible enough to accommodate differences in enrollments. The Android development course assigned students to project teams of three members. Only some of the three person teams would be assigned to work with an Applied Project Management team. The remaining three person teams would create projects of a reduced scope compared to the larger collaborative teams. Students taking both courses were permitted to submit a single project for both courses because of the significantly increased workload. These students would become lead developers of the collaborative team and would also help facilitate communication across the two sub-teams.

Massachusetts General Hospital (MGH) is a venerable institution which prides itself on its research, teaching and quality of health care. MGH is the oldest and largest hospital in New England, conducts the largest hospital-based research program in the United States, and supports Harvard Medical School in their capacity of a teaching hospital as almost all staff physicians at MGH are also faculty members of Harvard Medical School ("Hospital Overview - Massachusetts General Hospital, Boston, MA," 2012). Faculty at Bentley University have collaborated with researcher/clinicians at MGH on a number of projects over several years.

4. COLLABORATIVE ENVIRONMENT

The academic and business collaboration provided the capstone project teams with the ability to develop real world applications and prototypes to solve hospital needs. One such hospital business need is to provide patients and employees with an efficient method of arriving at their destinations. As in many hospitals, MGH patients are often bewildered trying to find their destinations through a maze of corridors. After presentations in 2011 of wayfinding application prototypes created by capstone project teams, MGH proposed in the spring of 2012 that a graphical cell-phone wayfinding application for the hospital's clinic and labs be created.

A collaboration between the capstone course, Applied Software Project Management, and the Android development course was formed to meet MGH's need. In the past, capstone student teams were required to self-learn whatever additional technologies were required for the real world project. However, given the complexity of a health clinic wayfinding mobile application, students faced the extraordinary obstacle of executing project management processes, learning the necessary mobile development environment, and developing a professional application within a single semester. Conversely, in the Android development course, students spent a tremendous amount of time determining what their final project would be rather than spending that time on actual application development thus leading to projects that were reduced in scope and complexity. The instructors of both courses devised a collaboration that coordinated their syllabi, merged project teams and aligned the final projects. The schedule of the Android development course was rearranged to present necessary technologies in advance of capstone course milestones. The coordinated course schedules are included in Appendix A.

A survey was administered to students on the first day of class to determine their individual course backgrounds and related previous work experience, if any. Based on this information, the instructors assigned three closely balanced development teams of seven to eight members each comprised of students from both courses.
Students taking the capstone course self-selected roles of project management, lead analyst/developer, project analyst, quality assurance manager and documentation/configuration manager. The students taking the Android development course served as lead and project analysts/developers. Course requirements were designed so that the same term project could satisfy both classes. Although instructors supplied general technical and management direction, no direct support was given to the teams in the development of their applications.

The MGH research scientist/clinician was an integral component of the capstone experience; he made himself available to the students throughout the semester by presenting the project in a class lecture, answering questions during the requirements gathering phase, and assessing the final projects to determine the winner of the competition. The direct interaction with the client lent encouragement and a heightened sense of importance to the students working on the team projects.

5. WAYFINDING MOBILE APPLICATION DEVELOPMENT

Student teams had to satisfy multiple sets of requirements from MGH and from each of the course instructors.

The MGH research scientist/clinician's application requirements set included the ability to run on a cell phone, scan QR codes for starting and ending locations, manual selection of starting and ending locations, generation of multi-floor paths with integrated clinic photos, a graphical display of the path superimposed on hospital floor plans, and built-in expandability to potentially accommodate the entire hospital campus.

In addition to an easy-to-use graphical interface, the Android development course required capstone teams to implement an Options Menu and ListView widget; implicitly call SMS, Dialer or Browser; use SQL; explicitly call at least three Android Activity components and incorporate customized colors.

The capstone course required student teams to survey potential users to determine which software features should be included in a hospital wayfinding application and which features should be avoided. Using information from the potential user survey, teams had to implement at least one major software feature that was not explicitly requested by the MGH research scientist/clinician and also include a Help Menu screen to assist users. A complete set of project management documentation was required: project charter, project management plan, cost-benefit analysis, software requirement set, software size estimation, work breakdown structure, software design documents, dynamic test suite, formal peer review of a project component, and a project risk analysis.

The Android mobile development course uses an open source technology platform for developing and testing Android applications. The standard Java Software Developers' Kit (SDK) is used with Eclipse as the development environment. In addition, Google's Android SDK and the required Eclipse plug-in provide the needed Android OS and emulator capabilities. Android was selected over competing mobile computing technologies because Google has chosen Java as Android's principal programming language, and the CIS Department at Bentley University teaches Java as the required programming language for CIS majors. SQLite or MySQL was used whenever a solution required a database. Students were required to install and configure this software on their laptops.

The wayfinding application consisted of numerous distinct components, enough to provide every analyst/developer with a significant part of the project. Application components consisted of the Android GUI menus, the QR code reader, graphical mapping, SQL database development for data storage, and implementation of the Djikstra algorithm and data structures to compute the shortest path from one vertex on a graph to another. The architecture chosen for the application development was determined by the student teams. In particular, teams had to choose whether to compute the paths dynamically as the application was being used, or calculate the shortest paths between any two locations in advance for storage in a database. Another choice to be made was whether to directly display the graphical map and calculated path on the cell phone or create the graphical map and path on a web page which would then be displayed on the cell phone. Yet another decision was whether to store data locally on the cell phone using SQLite, or store data in an external SQL database server using MySQL.

6. COURSE OUTCOMES AND EVALUATIONS

The competing student teams created three distinctly different but outstanding solutions for MGH's clinic. Screenshots of all three teams' applications are included in Appendix B. Team A chose a standalone architecture for the application implementation that used the locally accessible SQLite database and calculated paths dynamically. Team A's standalone application consisted of a streamlined, simple UI aimed at cell phone novices which was easy to use with streamlined menus and a minimum of methods to enter starting and ending locations. Instead, a great deal of effort was devoted to the graphical design and presentation of the maps and paths. This team implemented two significant additional features. The first feature is an optional text representation of the directions. The second feature was the selection of whether the user is an employee or a patient. If the user is a patient, then the destination paths would not proceed to a doctor's office but only to the reception area. A surprise outcome of this application was discovering that calculating and drawing paths dynamically using the Djikstra path-finding algorithm was fast enough to seem immediate to the user.

Team B's approach was to provide a user interface similar to that of GPS systems. This application not only provided graphical directions, but also voice-activated directions as well. Similar to GPS systems, arrows were included at the top of the graphical map to indicate what direction the next turn would be. Team B selected a client-server architecture with an external MySQL database used to store all of the pre-calculated paths between any two points. Upon starting the wayfinding application, the entire path database would be downloaded onto the cell phone.

Team C chose a three-tiered architecture using an external database, and a web interface for drawing the paths on the MGH maps. Team C's project, freed from the cell phone's data storage restrictions, was developed as a feature-filled, highly customizable application. Among the application features are multiple methods of entering locations, filtering by locations type, and display of points of interest through Google overlay markers. In addition, numerous application options can be set such as the path route line width and color, use of elevators or stairs, and default phone numbers and email addresses.

The Bentley CIS department faculty and the MGH research scientist/clinician were invited to participate in the final project presentations. Faculty members expressed a great deal of interest in the three implementations and asked each team detailed questions about their application architecture, design and feature decisions. In the course of the presentations a heated debate even ensued among the faculty as to which application and architecture approach would be the most scalable. CIS faculty interest in the wayfinding project was significant enough that a directed study has been created for Fall 2012 for the lead developers of the three teams to create an advanced mobile wayfinding application for the Bentley University campus.

In a subsequent presentation, the mobile wayfinding hospital clinic applications similarly impressed the MGH research scientist/clinician. All three teams were invited to present to MGH executive management who indicated an interest in funding the three teams to create a hospital-wide wayfinding application that includes the best features of each delivered application. The research scientist has since submitted a project proposal on behalf of the students and a response from MGH executive management is forthcoming.

Students in both courses felt the collaboration with the real-world client, MGH, achieved the goals of directly relating the course material through the development of a usable application, motivating students to excel in their endeavors, and providing them with a creative project. Students were especially excited over having the option to publish their applications in the Google Marketplace, running their applications on their cell phones, and demonstrating the applications to others. Moreover, the capstone course was successful in having the students synthesize the topics learned in the current class and the material learned in their previous CIS classes to create a real world application. A surprising outcome was that the multi-team coordination between students in the two courses actually reduced the incidence of uneven contributions.

Students gave both courses a high rating on Bentley's standard evaluation system: 5.45/6 for the capstone software project management course and 5.73/6 for the Android development course. Recently graduated students who participated in the capstone collaboration reported that they found both courses useful in their careers (see Appendix C — Student Testimonials).

7. CONCLUSIONS

We have described a three component capstone model — a collaboration among an applied software project management capstone course, a mobile development course, and a hospital as the external business partner — aimed at deriving student learning benefits from the different forms of collaboration. The collaboration between the capstone course and the real world client enhanced the students' learning by relating course material to a real world project, increasing the students' motivation and course performance, and improving their creative problem solving skills. The collaboration between the capstone course and the mobile application development course permitted students in both courses to implement and learn from a much more complex project than they would otherwise have been able to do, all within the framework of a single semester. The cross-course collaboration also increased students' preparation for the industry by providing them with soft skills gained from working on a multi-team project. Finally, the collaboration between the real world project and the mobile application development course provided students with marketable mobile computing skills and actual work experience.

The success of this collaborative model should be repeatable in other programs and universities where a desire exists to provide a capstone course with a complex, real world project that requires knowledge of technologies that can be taught in an advanced software development course.

A number of factors contributed to the success of the collaboration. First and foremost, was the cooperative attitude and trust between the course instructors and industry partner, and the instructors' strong commitment to improve the student experience beyond what a single course would be able to accomplish. A second success factor was the administration of a survey to determine student backgrounds for the purpose of forming balanced teams, each with the range of skills necessary for successful completion of the project. The trial runs were invaluable in uncovering potential problems prior to the formal implementation of the collaborative model.

One of the critical lessons learned from the trial runs was that the lack of syllabi coordination led the sub-teams to not interact with one another until much later in the semester thus causing delays in the application development and necessary reductions in the scope of the project. We realized that syllabi must be coordinated in a way that the material presented in the technical course lectures are delivered immediately prior to their need by the capstone course components. The outstanding hospital mobile wayfinding applications created by the students and other course outcomes provide evidence that the collaborative capstone model has been extremely successful.

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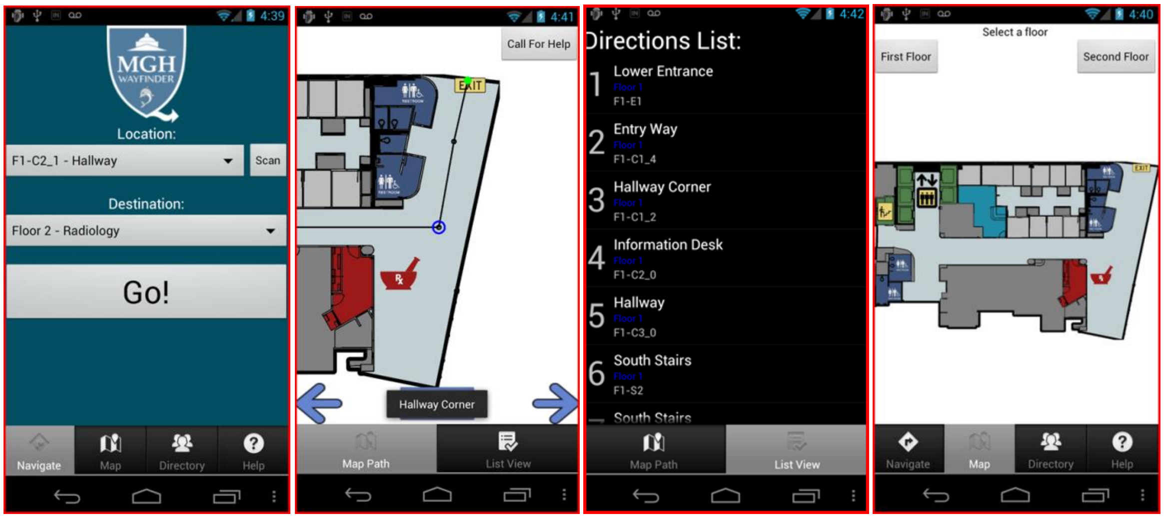
Appendix A
Joint Course Schedules

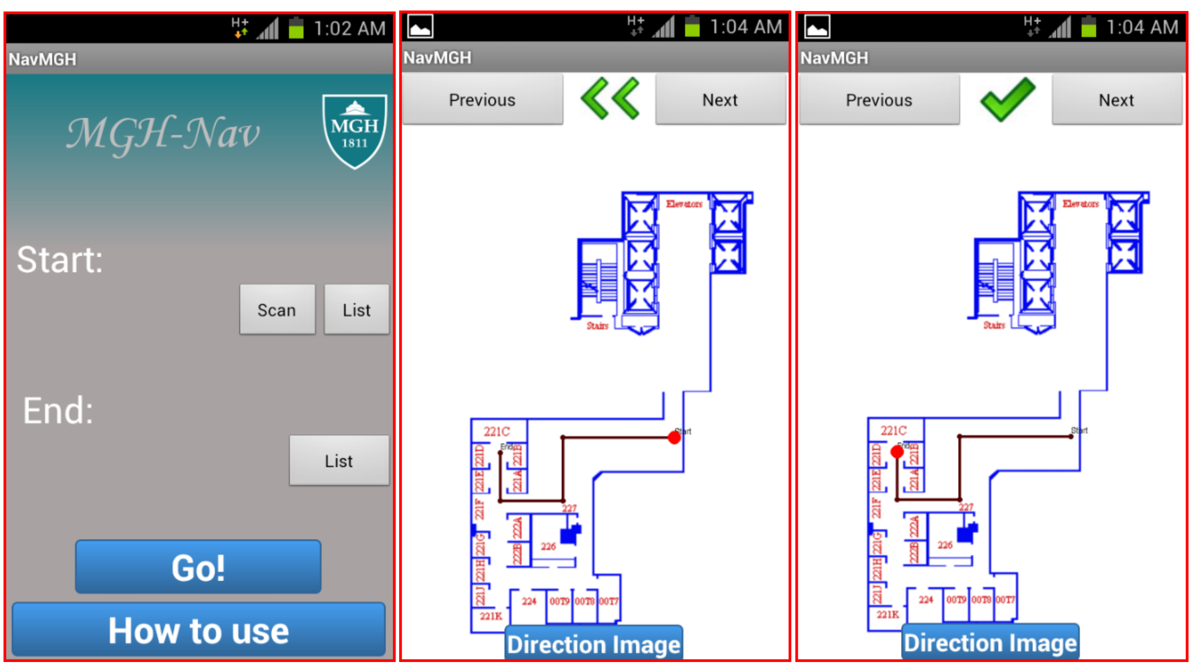
Week	CS460 Applied Software Project Management	CS402 Android Application Development
1	Course Introduction Software Project Goal and Scope	Course Introduction Introduction to Android
2	Software Project Teams Requirements Gathering Project Introduction and Team Meeting	Android Application Structure Activities Lifecycle Methods
3	Software Development Live Cycles Team Meeting	Basic Widgets and Listeners Resources
4	Work Breakdown Structure Team Meeting	Layouts Intents
5	Software Size Estimation Duration and Cost Estimation	Web Interaction Publishing Applications to Handset Widgets continued
6	Software Analysis and Design Team Meeting	Lists, Array Adapters Menus Java Threading
7	Midterm Presentations and Peer Reviews Software Design continued Software Specifications	Alert Dialogs Sensors Thread Synchronization
8	Quality Assurance Team Meeting	Intent Filters Audio/Video Google Maps
9	Risk Analysis Project Tracking and Control Team Meeting	Shared Preferences File I/O SQLite
10	Agile Development Methodologies Team Meeting	Location Based Services Map Overlays Animation
11	Term Exam	Message Passing Client/Server Model
12	Team Meeting	Services Broadcast Receivers
13	Team Meeting	Notifications Content Providers Content Receivers
14	Final Presentations Final Peer Reviews	Team Presentations

Appendix B
Wayfinding Application Screenshots

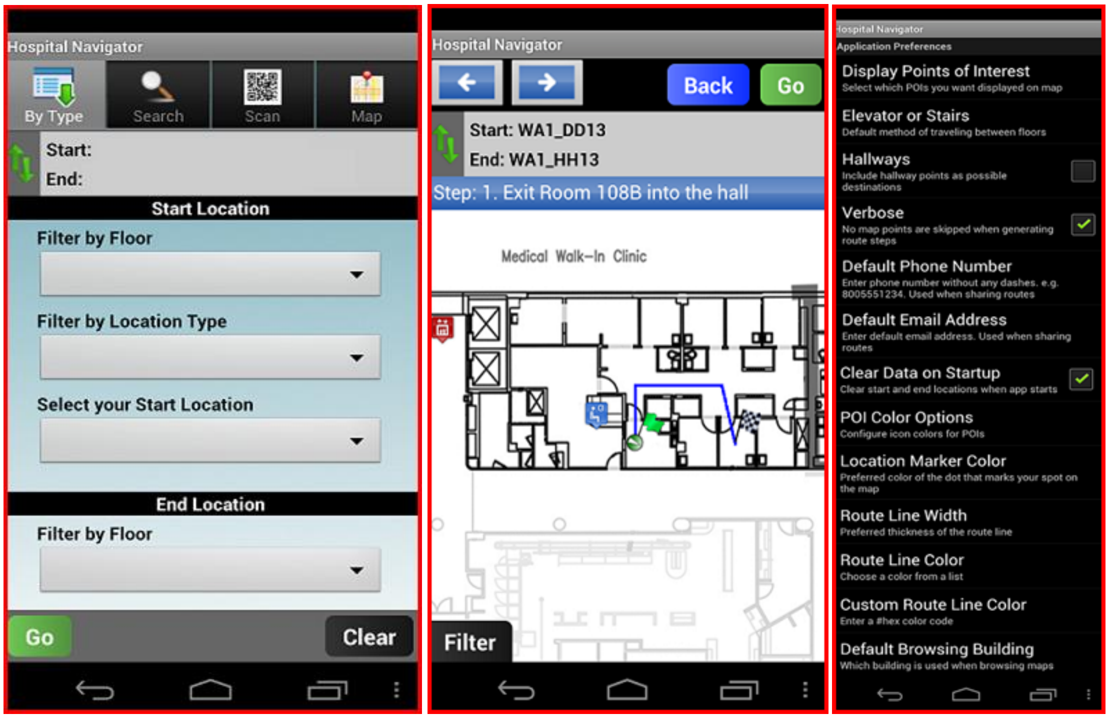
Team A: MGH Wayfinder



Team B: MGH-Nav



Team C: Hospital Navigator



Appendix C
Student Testimonials

"Although the course project is definitely the most time consuming project I have completed at Bentley, I love how everything we learn in class and read about in the textbook directly relate to the project. I also now have a great huge understanding of everything I have learned in the other CS classes - it's really cool how CS460 ties everything together."

"The unique group project was the best part of the class [CS460]. It made sure to encompass all of the material covered over the semester and it was motivating to work on a project that was going to be further developed with partners outside of Bentley."

"The best part of the class [CS402] was the group project and the assignments in general. They allowed the students to be creative and use the teachings from class to develop their own ideas on the platform."

"This was the only Bentley class I've taken that used team collaboration across classes, which I thought was a great use of resources. Both teams had the project at stake so there was no slacking."

"The actual content and what I was able to do after participating in the class [CS402] was most valuable to me and what I liked most."

From Bentley University's career services office:
"CS460 gave me the tools to truly be a good project manager for IT related projects, which definitely helps me in my current job."

Costs and Benefits of Vendor Sponsored Learning Materials in Information Technology Education

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Abstract

The demand for qualified information technology professionals remains high despite downturns in the economy. It is imperative to provide students with a curriculum that provides a broad foundation in information technology knowledge, skills, and abilities. Students also need access to specialized technologies and learning materials to develop the skills that will be needed to drive growth in companies across all sectors of the economy. The dilemma faced by administrators of information technology degree programs is the lack of resources needed to provide students with these specialized learning opportunities. Cisco, VMWare, NetApp, and other information technology vendors offer learning materials that can be used by higher education programs. The potential costs and benefits of using these resources and how they have been incorporated into the undergraduate Computer Technology program at Ball State University will be discussed.

Keywords: information technology, education, vendor sponsored curriculum

1. INFORMATION TECHNOLOGY EDUCATION

Information technology has long been recognized as a facilitator of economic growth (Stiroh, 2002, World Economic Forum, 2012). The U.S. Bureau of Labor Statistics (2012) projected that the demand for information technology professionals will increase by 28% over the period of 2010 – 2020. It is imperative that information technology education provide students with the knowledge and skills to take advantage of these job opportunities.

Curriculum designers in information technology are faced with the challenge of providing students with the resources they need to attain the learning objectives of their academic program. To meet this challenge, information technology vendors offer degree granting programs in higher education with learning materials at little to no cost (Cisco, 2012; NetApp, 2012; Microsoft, 2012; Oracle Academy, 2012).

Some of the challenges in providing information technology students with resources relevant to market needs will be presented. To address these challenges, the potential costs and benefits of using vendor sponsored learning materials, and the way they have been incorporated into the undergraduate Computer Technology program at Ball State University will be discussed.

Challenges

Hardware/Software Resources

One of the most formidable challenges for information technology programs is providing students with the hardware and software resources they need to learn the applied skills required to successfully enter into the information technology workforce. Students need the opportunity to develop the applied skills with the hardware and software that they are likely to encounter as they enter the technology workforce.

The need for hardware and software resources places a significant strain on educational budgets for information technology programs. Whether it is providing enough resources to serve a large student population or purchasing the enterprise level resources required for specialized classes, curriculum designers are faced with balancing experiential learning and conceptual learning opportunities.

Moving Target

Keeping curriculum up-to-date with the ever-changing face of information technology is a constant challenge. There is a foundation of fundamental concepts and theories that remain constant. Students should understand protocols like TCP/IP, DHCP, and DNS. They need to be aware of how these theories govern data communications. A thorough understanding of the core concepts and theories that underlie information technology provides students with a foundation upon which to build.

The challenge for information technology courses occurs when going from theory to practice. With every new technology, new version of an operating system, or modification of an application comes a major curriculum revision. In order to provide students with the skills needed to be employable in the information technology workforce, courses have to be constantly updated. This problem is compounded in courses that integrate multiple technologies that may have undergone major revisions. This leaves faculty in a constant state of course updating.

2. VENDOR SPONSORED LEARNING MATERIALS

All information technology manufacturers have learning materials about their products. Hardware and software vendors will use these materials to train their employees on the proper installation, configuration, and maintenance of their product. The challenge faced by vendors has been that there are not enough qualified professionals to implement the technology for their customer base (Hewlett-Packard, 2012). In the healthcare industry, it is being forecast that the information technology staffing shortage will hinder the ability of hospitals and other healthcare facilities to roll out new medical technologies (Bahensky, Ward, Nyarko, & Li, 2009; Zwylak, 2011).

To address the staffing needs of their customer base, vendors began by offering product specific certifications. These certifications provided information technology professionals with a set of credentials indicating that they have attained a certain level of knowledge or expertise with a product (Al-Rawi, Bouslama, & Lansari, 2006; Randall & Zirkle, 2005).

In 1989, Novell became the first information technology company to offer a vendor-specific certification (Ziob, 2000). Since then, vendors from all aspects of the information technology industry have been developing their own product certifications (Al-Rawi, Bouslama, & Lansari, 2006; Randall & Zirkle, 2005). Apple Computers, Hewlett-Packard, and other hardware vendors require technicians to earn their certification in order to do warranty repairs on their products (Apple, 2012; Hewlett-Packard, 2012). Cisco, Microsoft, NetApp, and other vendors have a progressive series of certifications that represent increasing levels of expertise in technical support, installation, configuration, and system design.

For the vendors, the primary purpose of these materials was to encourage information technology professionals to specialize in their products. However, the training materials for these certifications have also been used in information technology programs in higher education (Al-Rawi, Bouslama, & Lansari, 2006; Randall & Zirkle, 2005).

The certification preparation materials were originally intended for practicing information technology professionals. It was up to these practitioners to seek out the certification training materials and to take the certification exam. If higher education adopted these materials into their curriculum, it was simply a bonus for the vendor. However, some vendors recognized the value of using an educational model to organize and offer their materials to not only practicing professionals, but to educational institutions as well.

Cisco, Microsoft, Oracle and other vendors have developed comprehensive systems that provide a turnkey training solution to educational institutions (Sands, 2003). These systems were designed specifically for educational institutions. Each of these vendors has marketed its respective information technology academies to high schools, undergraduate programs, and graduate programs.

3. COSTS

Considering the use of a vendor sponsored curriculum should not be done without also considering the potential associated costs. Regardless of the vendor, each has a purpose for offering its learning materials. In pursuit of this purpose, vendors will have certain expectations of the faculty or institutions that are using their learning materials. It is incumbent upon the faculty to be aware of these expectations, or costs, before entering into any agreement with the vendor.

Financial Costs

There is almost always a financial cost associated with vendor sponsored learning materials. The amount of the cost depends on the vendor. The financial costs can be broken down into four categories: subscription fee, instructor preparation, equipment, and software.

Subscription Fee

The subscription fee is the price the vendor charges in order to gain access to their curriculum. Payment of the subscription fee typically gives the institution access to a prepared curriculum, lesson plans, course presentation slides, and course progress testing materials.

Some vendors, such as Microsoft, charge a flat, annual rate. Whether it is a high school vocational program, an associate or certificate program at a community college, or a bachelor degree program in information technology, the amount charged for the subscription is the same. Also, the subscription fee provides access to a variety of courses offered by the vendor.

Other vendors, like Oracle, will have a variable subscription fee based on the product lines the educational institutions want to utilize. Oracle offers a free introductory course to computer science that it markets to high schools. After that, there is a nominal annual fee per production line.

The Cisco Networking Academy had been operating under a different model. Individual academic programs would have local academies for their own students. These local academies reported to a regional academy that was responsible for providing a variety of services to the local academies. The policies of the Cisco Networking Academy granted regional academies the authority to establish their own price for providing these services to local academies.

Instructor Preparation

When using a turnkey solution for IT education, the vendor may have expectations of those who will be providing the instruction. Some vendors may require the instructor to obtain the certification for which the teaching materials pertain before being allowed to teach that class. With this requirement, the decision has to be made as to who will be responsible for the cost of the certification. This issue is complicated further if the intended instructor does not pass the certification exam on the first attempt. Will it be the responsibility of the individual instructor or the institution to pay for the subsequent examinations? Also, how will not passing a certification examination impact the instructor's employment?

In addition to the cost of the certification exam, there may be a cost for preparing the instructor for the examination. The Cisco Networking Academy requires that an individual complete a training session before being granted authorization to teach their curriculum. The cost to attend these training sessions was usually incorporated into the fees paid to the regional academy.

Equipment

A major cost associated with any information technology curriculum is the hardware. Adopting vendor sponsored learning materials does not necessarily remove or reduce this cost factor. It can be quite the contrary.

The standard bundle of equipment recommended for the Cisco Networking Academy costs in excess of $10,000. Depending on the number of enrolled students, a single bundle of hardware may be insufficient to provide all of the students with reasonable access to the equipment needed to complete the labs. In a class of twenty students, a minimum of four bundles would be needed to allow students to work in small groups during a class session. If required to work on labs outside of class time, fewer bundles could be purchased. However, this may require students to reserve time on the equipment during a limited set of open lab hours. If that equipment is shared by multiple classes, then the competition for lab time increases significantly.

In addition to networking equipment, personal computers and servers will be required to access or use the learning materials offered by the vendors. Personal computers will be required to access resources in many of the turnkey solutions. The vendors provide e-learning websites to provide the curriculum to the students.

With many of the vendor sponsored learning materials, a personal computer may not be sufficient. Topics that deal with enterprise infrastructure services are going to require servers. Within the Microsoft IT Academy, courses may cover Windows Server 2008, Exchange, SQL Server, or Share Point. The VMWare curriculum explores a broad spectrum of virtualization topics including server virtualization, cloud computing, and virtual desktop infrastructure. NetApp and EMC both focus on enterprise storage issues. Enterprise level software and services require a server with enough processing power, RAM, and storage capacity to support them. A basic rack mount server to support these applications will cost several thousands of dollars. The cost is compounded when trying to provide enough servers for multiple students or groups of students to work on simultaneously during a lab session.

Software

Students need the opportunity to work with the latest versions of operating systems and applications. With that knowledge, students will be better prepared to provide recommendations on how to use the software to effectively support the organization's goals and objectives. The retail cost to purchase single copies of the software from Microsoft and VMWare can easily exceed $5,000. As with the hardware, providing enough licenses for students to use on lab hardware drives the cost up quickly.

Another issue to consider is the students' access to the software from their own personal computers. Many students must work at least one part-time job to help pay for their college expenses. This can make it nearly impossible for students to take advantage of open lab hours. If students could load the required software on their own hardware, they could work on their labs when they had time available. Also, it would give students the chance to explore the capabilities of the software beyond what was covered in class. However, the retail cost of the software may be beyond the financial capabilities of the students.

Academic Freedom

The biggest potential cost to using vendor sponsored learning materials is a loss of academic freedom. In higher education, it is the responsibility of the faculty member to determine the materials to be covered, the pedagogical strategies, and methods of assessment. The faculty member must have the autonomy to make decisions that will help the students accomplish the learning outcomes of a course.

Utilizing vendors sponsored materials holds the risk of sacrificing a degree of academic freedom. This can occur when the learning materials are not in alignment with the course objectives. The extent to which this may occur depends on the expectations of the vendor.

The Cisco Networking Academy offers a well-structured learning environment. While the Cisco Networking Academy offers several different courses, the primary purpose is to prepare students for the CCNA certification examination. Cisco organizes the materials into four sections. As part of the license agreement to participate in the Academy, the educational institution has to agree to annual quality assurance reviews. The purpose of these reviews, in part, is to ensure that local academies are providing effective training according to Cisco guidelines. The review incorporates a site visit at which students, instructors, and administrators are interviewed. As an academician, this can be seen as an intrusion on a faculty member's academic freedom to choose how to teach a class.

The loss of academic freedom can also be seen in the assessment process of some of the turnkey solutions. Within the Cisco Networking Academy, the quizzes and exams are developed by Cisco. The instructor does not have the freedom to modify the only assessment items. The loss of academic control can also be found in practical examinations that rely on vendor developed simulators. These simulators can have overly restrictive criteria. Whether the student is working with Excel, Windows Server 2008, or configuring an access control list in the Cisco IOS, there are typically multiple methods to successfully accomplish a single task. The simulators are usually programmed to anticipate a single method. The student will not receive credit for the task unless that predetermined method is utilized.

4. BENEFITS

Cutting Edge Materials

The vendors that are engaged in developing learning materials for use in higher education are the leaders in their respective industries. Whether it is Cisco and networking or the combined storage market presence of NetApp and EMC, these vendors are creating the technologies and practices that will be used in enterprise infrastructures. It is this knowledge that they are incorporating into their learning materials. The transfer of knowledge from vendor to students is facilitated through their e-learning websites. Vendors have the discretion to update their e-learning materials when needed without the time delay required to update a traditional textbook.

The NetApp Academic Alliance offers the Learning Resource App. This is a desktop portal application used to pull together the most current resources for a topic. There are prepared packages for the Learning Resource App that cover virtualization, cloud computing, and private cloud infrastructure. Instructors can also work with a NetApp representative to populate the contents of the Learning Resource App. The contents may include publicly available information or NetApp proprietary learning materials. There may be white papers, webinars, videos, or e-learning modules. The flexibility this provides allows an instructor to collaborate with industry professionals to customize a set of resources that directly address the goals of a particular course. It can accommodate a week long review of a topic or provide enough resources for an entire semester.

For an information systems class, the instructor may choose to focus on the business impact of virtual desktop infrastructure. The Learning Resource App could then include white papers that provide an overview of the technology; case studies on the impact of virtual desktop infrastructure on organizations with respect to cost and productivity changes; and webinars with industry professionals discussing the topic.

By contrast, an information technology class may be more interested in the technical aspect of virtual desktop infrastructure. The instructor may desire technical documents on design and installation of a virtual desktop infrastructure implementation. The case studies may focus more on highlighting the network infrastructure required to deliver a virtual desktop experience that minimizes delay. The Learning Resource App may link students to e-learning activities that provide visual instruction on the installation and configuration of a virtual desktop infrastructure solution. Ultimately, the instructor can collaborate with NetApp to gather the most appropriate resources available for the students.

Industrial Strength Tools

It is always optimal to provide students with the opportunity to have hands-on experiences with the technology that they are likely to encounter when they enter the workforce. However, providing enough hardware and software to achieve the goal is cost prohibitive. Participating in these vendor learning communities can provide access to “tools” that may lower the cost of educating the students for both the academic unit and the student.

Data storage has become a critical aspect of any enterprises technology infrastructure. There has been exponential growth of data resulting from corporate databases, e-mail, websites and other digital activities. Information technology administrators are trying to find effective and cost efficient strategies of managing the large volume of corporate data. Trying to provide students with experiential learning opportunities in data storage may not be possible without access to the tools that can be available through vendor learning communities.

The NetApp Academic Alliance provides faculty and students with access to resources that are used by their own engineers. NetApp allows instructors and students to use their VSIM virtual machine. The VSIM virtual machine contains the operating system found in NetApp’s enterprise storage devices. Along with the NetApp System Manager software, instructors are able to develop labs that require students to develop and implement comprehensive data storage strategies.

In small groups, students in a data storage class in the Computer Technology program at Ball State University used the VSIM to create an iSCSI SAN environment in which they created LUNs that were attached as volumes on production network servers. The students then used Active Directory and NetApp System Manager to create a secured storage environment based on a set of organizational design requirements presented by the instructor. This was all accomplished without having to purchase any additional hardware or software beyond the desktop computers and network already available in the classroom.

The experiential learning opportunity just described did leave out a key component. In addition to the tools available through NetApp, a virtualization solution was required. For this, the resources through the VMWare IT Academy provided students with the tools needed to run virtual machines for the NetApp VSIM and production servers. Participating higher education programs are able to use VMWare Workstation, vSpere, vCenter, and other virtualization products at no cost by VMWare. Access to these tools benefits the students by being able to implement virtualization solutions that are dominating how information technology is being implemented in enterprises. It also serves as a cost savings for the academic program by reducing the amount of hardware required to provide students with a robust experiential learning environment.

The Cisco Networking Academy offers Packet Tracer to participating programs and their students. Packet Tracer is a network simulation application in which instructors and students can design, build, and configure complex network topologies. In a networking class, the instructor can provide students with a topology that they then have to configure and test to verify functionality. Packet Tracer supports a broad range of networking protocols. Packet Tracer's simulation mode can be used to graphically display how fundamental protocols within TCP/IP function. In realtime mode, the simulator supports a variety of routing protocols (rip, ospf, eigrp, bgp), switching protocols (vlan. vtp, multilayer switching, QOS, etc.), wireless access points, and end devices (computers, servers, printers).

Students are able to download and install Packet Tracer onto their own computers from the Cisco Networking Academy website. While it is not a substitute for working on actual hardware, it does allow students to practice their network design and configuration skills outside of the classroom. Recent upgrades to Packet Tracer allow a topology created on one computer to interact with a topology created on a different computer. With this capability, instructors can create scenarios in which students are network administrators responsible for integrating two separate networks after a corporate merger.

Student Recruitment

The use of vendor sponsored learning materials can increase an academic program's visibility to potential students. When engaging in recruitment activities, faculty and admissions personnel can share how industry leading vendors are contributing to the student's learning experience. They can also share the impact that this exposure may have on the student's employability upon graduation.

There is also a linkage between high schools and higher education available with the Cisco Networking Academy. The original intent of the Cisco Networking Academy was to increase the number of students coming out of high school who wanted to pursue careers in information technology. The Cisco Networking Academy website indicates that their curriculum is being used at over 600 high schools and 2600 colleges and universities worldwide (Cisco Networking Academy, 2012). At the training opportunities offered through the Cisco Networking Academy, high school and college instructors have the opportunity to interact. From these interactions, high school instructors are given the chance to encourage their students to continue their education at the higher education institutions that are also using the Cisco Networking Academy.

These interactions have led to more formalized arrangements between high schools and colleges. In an era of Advanced Placement and dual credits coming out of high school, potential students were asking whether their participation in the Cisco Networking Academy in high school could be applied towards their college education. To varying degrees, higher education has responded to these requests (Ball State University Cisco Academy Training Center, 2012).

Some higher education programs will give incoming students general credits for their successful completion of the Cisco Networking Academy. In this situation, the student would not receive credit for a specific class in the degree's curriculum. Instead, the credits would only be applied towards the total number of credits hours required by the institution to graduate.

Other higher education programs have taken the next step by offering students credit for specific classes. This may be awarded by completing the Cisco Networking Academy curriculum and also successfully earning the CCNA certification. Another alternative has been establishing a dual-credit relationship between a higher education program and a specific high school (Montgomery County Public Schools, 2012; North Tech High School, 2012). Each of these college credit opportunities are being used as an enticement to recruit high school students to matriculate to an institution's information technology degree program.

5. BALANCING ACT

Retain Academic Control

The most important thing an instructor should do when utilizing vendor sponsored learning materials is to retain academic control over the class. It is incumbent upon the instructor or curriculum designer to review the materials offered by these vendors and determine the degree to which those materials support the learning objectives of a course. The use of these vendor materials can be criticized as a "sell out" to the technology vendors. The basis for this criticism is the assumption that students are only being exposed to the equivalent of corporate "propaganda" that espouses their own products. In response, there is merit to this argument. However, it is limited.

Cisco, NetApp, EMC, and other vendors have recognized this criticism and attempt to provide their educational materials in a vendor neutral manner. This is accomplished by emphasizing the concepts, theories, protocols, and design considerations that underlie the technology. These learning objectives are completely independent of varying manufacturers of the technology.

It is when the learning materials make the transition from theory to practice that vendor specific materials come into play. At some point, it becomes necessary in an experiential learning environment to interact with hardware and software in order to develop the applied skills demanded by employers. It is reasonable to adopt a vendor's product in order to provide students with chance to develop these applied skills. As long as the student understands the underlying foundations, the primary difference between configuring a Cisco Catalyst switch and an HP switch is the syntax. VLANs and the IEEE 802.1Q protocol work the same way on both devices.

If this logic is accepted, then the use of vendor sponsored learning materials does not automatically constitute a compromise of an instructor's academic freedom. At the same time, it is not an endorsement for faculty to blindly accept the content, delivery, or assessment strategies provided by the vendor. There is nothing restricting an instructor from creating an additional assessment outside of the confines of a particular vendor's learning environment. The students can be given a task of the instructor's choice and have the flexibility to utilize any method that is appropriate to solve the task. The instructor must strike a balance that provides students with relevant content and resources while meeting the requirements of the vendor.

Tool Box

To achieve that balance, an instructor needs to consider the strengths and weaknesses of the resources at his or her disposal. When an academic program has arrangements with multiple vendors, it is like having a well-equipped tool box. The trick is finding the right tool for the job at hand. An individual vendor is likely to present lesson plans based on the tools that they provide. An instructor with access to a broader set of tools should be able to develop a more comprehensive learning experience by integrating resources from different aspects of an enterprise infrastructure. In so doing, the students begin to comprehend the interactions and interdependencies that occur between the network infrastructure, server hardware, operating systems, and enterprise applications that are found in corporate information systems.

In a systems administration course at Ball State University students were introduced to DNS and DHCP. Students were asked to configure these services on a virtual machine of a server operating system on their individual desktop computer and be done. However, how often are end users located on the same physical computer that is hosting those services? Enterprise servers are usually located on a different part of the network.

Access to the various vendor resources has allowed the design of that lab to be more robust. The limitations of the previous example and expand upon. Having adopted various vendor learning opportunities into the Computer Technology program at Ball State University, the instructor hands out a network topology and the students have to develop an appropriate IP subnet strategy. Students then use Packet Tracer to create a test build of the network infrastructure and verify that the IP subnet strategy and network device configurations are correct. The configurations from Packet Tracer can then be imported into actual Cisco switches and routers in accordance with the topology. Students then connect desktop computers to different subnets on that physical topology. With VMWare Workstation obtained through the VMWare IT Academy installed on one of those desktop computers, students create a virtual machine for the server with Windows Server 2008, R2 ISO downloaded from the Microsoft IT Acadamy via DreamSpark.

By taking this approach to a DNS or DHCP lab assignment, students learn much more than just how to create a scope within DHCP. Instead of being given a set of IP addresses to use, students experience the impact of the IP strategy they had developed. They have to diagnose that the range of addresses for their subnets was wrong if they received IP address overlap errors on the routers or DHCP scopes. After correcting the IP subnet strategy, students would then have to reconfigure IP addresses on network devices, static IP addresses on the server, IP addresses of DNS entries, and scope configurations in DHCP. By combining the available tools, students develop an appreciation for the development and planning stages when designing an information technology infrastructure. It also fosters critical thinking skills that are needed to be an effective technology troubleshooter.

Low Cost Providers

Both Microsoft and Oracle charge set fees to participate in their academies and so there are no lower cost alternatives for these resources. When possible, however, seek out the low cost providers of vendor sponsored learning materials. With the Cisco Networking Academy, academic programs could choose the regional academy through which they would access the Cisco materials. Since these regional academies were able to determine their own price based on the additional services they provided there local academies, curriculum designers could shop around for the regional academy that provided the services they needed at a price that was within their budget.

Other vendors have taken the position that they will not charge higher education to participate in their learning communities. They provide access to higher education programs free of charge. NetApp, VMWare, and EMC have adopted the philosophy that providing higher education with their learning materials is an investment. For every dollar put into their learning communities, they anticipate a delayed return on investment. The objective for these vendors is to increase the number of information technology professionals who are skilled in their product lines.

6. CONCLUSIONS

With declining budgets in higher education, the challenge of providing students with the resources they need has become increasingly difficult. Curriculum designers face the constant challenge of providing students with hardware, software, and current learning materials.

The use of vendor sponsored learning materials can provide curriculum designers in information technology programs with a broad range of cutting edge materials. Leading hardware and software developers in the information technology industry are granting higher education faculty with access to the newest releases of operating systems, server applications, simulators, and learning materials at little to no cost.

Despite the potential benefits, the decision to adopt vendor sponsored materials into an academic program should not be taken lightly. While the vendor may not charge much to use their materials, there are likely to be a number of support costs. These costs can stem from subscription fees, hardware, and software to support any single vendors learning materials. A more significant cost to consider is the potential loss of academic freedom when trying to fulfill appropriate usage requirements by the sponsoring vendor.

Ultimately, faculty need to retain academic control of what occurs in their courses. Instructors need to recognize that the vendor materials are tools. It is up to the instructor to choose the most appropriate tools to assist the student in attaining the learning objectives for a given course. This is done by balancing the needs of the vendor with the needs of the students. When done effectively, students can be provided robust learning opportunities that foster critical thinking and develop a more comprehensive knowledge of the interactions between different technologies.

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Virtual Teams and Synchronous Presentations: An Online Class Experience

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Abstract

Global expansion, cost containment, and technology advances have all played a role in the increase of virtual teams in today's workplace. Virtual teams in an online graduate information technology management class prepared and presented synchronous presentations over a business or non-profit sector case. This paper includes a brief literature review of virtual teams and synchronous presentations, strategies suggested for virtual teams, the process used for this assignment, and feedback from the students in the course. The students in the course overwhelmingly recommended the format of the virtual team synchronous case assignment for other online projects. Lessons learned as recommendations for future implementation are also included.

Keywords: virtual teams, synchronous presentations, online classes, teamwork skills, online collaboration software.

1. VIRTUAL TEAMS

Virtual teams have three common attributes. A virtual team must have interdependent tasks and share responsibility for their outcomes, be geographically dispersed, and rely on technology for communication (Cohen & Gibson, 2003). Virtual teams are becoming increasingly common in today's organizations due in part to rising fuel and office space costs (Bullock & Klein, 2011) and advances in information and communication technologies (Bell & Kozlowski, 2002). Accordingly, a survey of senior leaders and hiring managers of Fortune 500 companies reported that 40% of the respondents stated at least 40% of their employees work on virtual teams and 56% of the hiring managers expected the trend to increase (Bullock & Klein, 2011). Benefits to organizations include the ability to select the most qualified individuals for a virtual team project without concern for location, to respond more quickly to increased competition, and to offer employees increased flexibility (Bell & Kozlowski, 2002). Companies not willing to use virtual teams could miss opportunities in today's increasingly competitive and quickly changing global economic environment (Berry, 2011).

To prepare to be effective virtual team members, college graduates need to develop virtual teamwork skills including communicating effectively, working with team members to solve problems, negotiating with colleagues, resolving conflicts, and collaborating with people from other cultures (Goold, Augar, & Farmer, 2006). Building these skills is important for successful careers so incorporating practice into graduate work is appropriate (Lee, Bonk, Magjuka, Su, & Liu, 2006). In addition, virtual team activities can increase student interactions and idea sharing which can both contribute to more reflective thinking (Lee et al., 2006). Since online students are already geographically dispersed and rely on technology for communication, incorporating virtual team projects into online courses is a logical step.

Ubell (2010) suggests including a team project in every online class.

2. SYNCHRONOUS PRESENTATIONS

Synchronous presentations can be included as a part of an online virtual team project. Synchronous presentations require all participants to be online at the same time for the presentation. Assignments that require students to practice communication and presentation skills can be beneficial to their future career. Presentation and communication skills continue to be listed as some of the most valuable skills to industry employers (American Marketing Association, 2010; Ubell, 2010). In a survey of over 2,000 managers, over 80% of respondents agreed that employees are annually evaluated on their communication skills while under 50% believed their employees had above average communication skills (American Marketing Association, 2010). Presenting online offers new challenges for students as there are fewer visual cues and an increased level of technological expertise required. With the trend toward virtual teams and meetings, students who have online presentation skills will likely be valued by employers (Flatley, 2007; Ubell, 2010).

To help students gain experience with both virtual teams and synchronous presentations, an online graduate Information Technology (IT) Management course required students to participate in an assigned virtual team and make two formal synchronous presentations.

3. TEAMING AND PRESENTATION PROCESS

Students in the IT Management fall online course were online MBA students who were geographically dispersed making face-to-face meetings impossible. Prior to dividing the students into virtual teams, the students participated in multiple threaded discussions. The first one was the typical course introduction. The next discussion was over electronic document management and virtual teams, a topic that was being studied early in the course. The discussion was a starting point to get students to think about the best ways for virtual groups to share files and collaborate on tasks. While students seem to prefer sharing files through email attachments (Berry, 2011), this discussion provided the forum for students to read text and watch videos to learn how businesses share files and collaborate on team projects. In this discussion, SharePoint, Dropbox, Google docs, and SkyDrive were among the topics discussed. In addition to electronic document management, the students also did research and posted articles about best practices for virtual groups. Since students would need to be available at the same time for synchronous presentations, the next discussion was an availability discussion that asked students to respond to the days of the week and time(s) of day that would work best for them to meet. Once the students had all posted their time availability, the instructor used this information to assign teams of 4-5 students. While students may like the idea of forming their own team, self selection of work teams is not real world (Goold et al., 2006) and can be challenging in an online course where students are not physically meeting.

Once the virtual teams were created, the instructor created groups within the course management system so each team would have a document sharing area and a dedicated threaded discussion area where only the instructor and team members could view documents and entries. Having a shared common space is essential for virtual teams (Ubell, 2010). The students could also email their team through the group management feature in the course web site.

There were several required assignments to help the teams form and get started on the case assignments that they would present. These requirements provided a sense of connection, clear rules for expected participation, and a project plan for completion (Berry, 2011; Koh, Barbour, & Hill, 2010). Establishing communication norms is important as the patterns started early tend to persist (Cramton & Orvis, 2003; Cummings, 2008).

First, students were to post another more detailed introduction in the team’s threaded discussion area. A challenge with virtual teams is to get them comfortable with each other so they will share information early (Berry, 2011). This requirement facilitated early conversations. Next, they were to discuss ideas for document management and a plan for their first assignment. While all teams had a document sharing area on the course web site, other online services offer different or better features so the teams were not required to use the course web site for document management. They also were to generate a plan and time line for their first assignment so all members would feel comfortable with the team's progress. Since some online students wait until the last minute for participation and submission (Goold et al., 2006), this plan was meant to help all students with time management and accountability. The last discussion point was to determine some common meeting times so they could all meet with the instructor to give their online synchronous presentations.

The synchronous presentations were given using Elluminate, an online collaboration tool. The instructor had previously used Elluminate software to create audio PowerPoint lectures over each of the textbook chapters so the students had seen the Elluminate room, but these videos were prerecorded so they had not interacted in the room. The Elluminate room provides a space for multiple people to enter the collaborative online space to use audio and video, upload files, participate in a chat, raise their electronic hands to ask a question, mark up slides, or write on a whiteboard. Since technical and behavior training are important when using online collaboration technology (Chilton & McHaney, 2008), and online students can experience frustration with technology problems (Koh et al., 2010), students were provided with instructions and links to Elluminate training. In addition, the instructor had six open sessions where students entered the Elluminate room, tested their audio, uploaded a PowerPoint file, advanced through the slides, and practiced using the other features such as raising their hand and drawing on slides. All students were required to participate in one of these sessions. This was an important step as it allowed them to feel more comfortable with the software and address any technical issues with their computer or microphone prior to the team presentations.

The assignments for the online presentations in this class were business or non-profit sector cases involving information technology. Students were given the case background and potential questions to address and then were to use current research to explore other technologies, businesses, or organizations. The deliverables were PowerPoint presentations with additional details and references in the notes pages. All teams emailed the instructor three different meeting times that would work for a presentation. The instructor selected a time that would work and responded via email and posted the schedule on the web site. The team members and instructor entered the room at the scheduled time, and the virtual student team gave their presentation, with the students taking turns advancing slides and using audio to share more details about the topics listed on the slides. Following the presentation, the instructor asked questions about their presentation and the team members were able to take turns and answer the questions.

Students were given the opportunity to complete a team evaluation form to provide feedback on the contributions of all team members. The feedback from these forms affected an individual team member's grade. Since most students had a positive experience, very few student grades were negatively impacted by the peer evaluation forms.

This process was repeated in a summer online course with MBA and computer science graduate students.

5. FEEDBACK

A total of 58 students (22 in the fall course and 36 in the summer course) answered follow-up questions regarding their experience with the synchronous presentations. While 67% of the students had participated in a virtual classroom, only 19% of them had presented using online collaboration software. Overall, they reported a good experience with 97% of the students recommending the format for other online class projects. Since virtual presentations using web conferencing software such as GoToMeeting, WebEx, and Live Meeting are gaining popularity (Boulton, 2009), these virtual group case presentations appeared to play a positive role in the course and the career preparation for the students.

The students shared both benefits and disadvantages of the virtual team presentations. In analyzing the student comments on the benefits of working on a virtual team, three common themes emerged. One, students appreciated the introduction to new technology tools. They valued the exposure to and experience with both the online collaboration and presentation software and the various software tools the teams used to share their files and ideas as they prepared their cases. Two, the virtual teams provided students flexibility. They mentioned that they liked being able to work at their own location without travelling to meet at a physical location. Since many graduate students have other commitments such as full-time jobs and families, this was a common benefit cited. Three, many of the students recognized that virtual teams currently are or will be a part of their careers so they appreciated the practice with a virtual team. Some mentioned the virtual team in the classroom resembled their current work environment and others liked the experience of working remotely with other students on a team. Some students appreciated the chance to get to know students from other parts of the world, realizing culturally-diverse work teams may be a reality in their careers.

The students also shared disadvantages of the virtual work teams, and two main themes were apparent. The first issue was technology problems. Slow Internet service, weather-related outages, and other computer issues affected a few students. The second disadvantage related to common team issues for both traditional and virtual teams. Challenges shared included not enough communication between team members, a lack of informal conversations, differences in work pace, and scheduling issues.

6. LESSONS LEARNED

Virtual team projects will continue to be a part of the IT Management online graduate course so learning from past experiences and student feedback is an opportunity to improve for future assignments. The required posts in the team threaded discussion area and the project plan assignment will remain part of the course so students can begin the teaming process. In addition, the project plan assists teams in establishing clear guidelines that can help with task effectiveness (Lee et al., 2006). The training over the software and the practice sessions will also continue as an integral part of the experience. Several students mentioned the value of the practice session prior to the synchronous presentations.

Increased informal communication between team members and between team and instructor would be one enhancement to make for future virtual team projects. Frequent informal contact may be a fundamental way to check in with a dispersed group (Cummings, 2008). In addition to monitoring communication, an instructor should be prepared to intervene when necessary (Cramton & Orvis, 2003). In future courses, the instructor could send more frequent emails to check in with teams and to make sure they are on track. These could be helpful, especially if there are teams with members not communicating or contributing. In virtual student teams, common sources of conflict are going silent, low work quality, and accusations of plagiarism (Ubell, 2010). In one team, the instructor did help team members “fire” a student from the group as the student was not participating. Since these groups were not assigned a team leader, the instructor intervened to help deal with this problem. If more frequent posts in the threaded discussion were required or an opportunity to reply to an email from the instructor was available, this problem might have been addressed earlier.

A second improvement is to incorporate contingency planning into the assignment. While students need to learn how to troubleshoot simple technical issues such as audio not working, they also need to be prepared for some issues beyond their control. During one presentation, one team member’s Elluminate session repeatedly terminated. No one else in the group could do his part so the team struggled to complete the presentation. Now as part of the project plan, teams are to have a contingency plan for each student in case there is a technical issue or other emergency that prevents their attendance. As part of the plan, students can also brainstorm other backup procedures including conference calls or the use of other collaboration software.

7. CONCLUSION

An IT management course where students learn both business and technical topics is an appropriate place to provide students with virtual team project experience including synchronous presentations. Students in the class learn how current technology trends impact business information systems used in today’s companies and organizations. They can then practice using the new technologies in their virtual teams. The opportunity to give synchronous presentations allows students to enhance their teamwork and communication skills for future business or technology careers.

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A Longitudinal Study Assessing the Microsoft Office Skills Course

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Abstract

This paper explains a four-year longitudinal study of the assessment process for a Microsoft Office skills course. It examines whether there is an increase in students' knowledge based on responses to pre- and post-surveys that asked students to evaluate how well they can do particular tasks. Classical classroom teaching methods were used in the first two years of the study; computer-mediated learning plus classical methods were employed in the last two years. The study further examines whether that change to computer-mediation made a difference in student learning. It also examines whether students retain the knowledge as measured by entrance surveys in a follow-on course. Results indicate that the course does make a difference in student learning of Microsoft Office skills. Results also indicate that computer-mediation does appear to make a positive difference in the mastery of Microsoft Office skills in the basic computer skills course although computer-mediation did not make a positive difference in retention of that mastery at the beginning of the follow-on course.

Keywords: course assessment, Microsoft Office skills, pre-post survey, computer-mediated learning

1. INTRODUCTION

Assessment is a critical success factor for higher education institutions which expend increasing efforts to evaluate effectiveness of programs within the institutions and courses within those programs. This paper looks at assessment of a Microsoft Office skills course in a western U.S. public university. For decades, the course has been taught by classical instructor presentation plus supervised lab sessions. In the last two years of the study, computer-mediated instruction was added, specifically using SAM 2007 from Course Technology Cengage Learning, a web-based content delivery and student assessment tool.

The range of skills that students are expected to master in such a course is extensive. One challenge with assessing such a broad set of skills is the large amount of instructors' time required to evaluate and measure the skills if each student was to demonstrate each skill individually to the instructor. Moreover, if the goal is to measure whether the course helps students to develop skills, the measurement needs to be both at the beginning and end of the course. Hence, the instructors' time to do the assessment doubles.

Consequently, a decision was made to conduct the assessment by simply asking the students at the beginning and at the end of the class whether they possessed the set of skills. Half-way through the four-year study, another decision was made to augment the class with computer-mediated delivery, specifically using SAM 2007 from Course Technology Cengage Learning. This study, therefore, is able to measure not only whether the course accomplishes its goals to improve student learning of Microsoft Office skills but also whether the computer-mediation tool has any significant impact on student perceptions of their skills mastery. An additional decision was made in the last semester of this study to assess incoming students in a follow-on course, allowing this study to measure retention of the Microsoft Office skills.

2. LITERATURE REVIEW

A full review of the assessment literature could fill several pages and is beyond the scope of this paper. These authors assume that the need for course assessment is understood by informed members of the academic community who are the intended audience of this article. Rather, attention is briefly focused on aspects of the particular form of assessment used in this study.

Accrediting organizations specify the need to demonstrate appropriate assessment (e.g., HLC, 2012) and explain acceptability of course-embedded measurement while strongly encouraging outcome-based assessment (e.g., AACSB, 2012). Roberson, Carnes & Vice (2002) promote assessment based on required student competencies. Palomba & Palomba (1999) include pre-post tests in their list of several commonly used assessment tools. Other scholars (e.g., Rockman & Smith, 2005) have commented on the need to assess computer technology literacy in higher education. This study incorporates all the above concepts and techniques.

3. RESEARCH QUESTIONS

Questions this study attempts to answer are:

1. Does the course help students build Microsoft Office skills? This is measured by comparing post-survey scores to pre-survey scores in the four-year study.

2. Prior to using the computer mediation, did the course help students build Microsoft Office skills? This is measured by comparing post-survey scores to pre-survey scores for the first two years of the study.

3. Does the use of computer mediation improve on the students' building of Microsoft Office skills? This is measured by comparing post-survey scores to pre-survey scores in the last two years of study.

4. Are there significant differences in learning using computer mediation in the basic Microsoft Office skills course versus only the use of traditional classroom instruction? This is measured by comparing results from the first two years of the study to results from the last two years of the study.

5. Do students retain skills beyond the course? This is measured by examining the entrance exam of a follow-on advanced computer skills course that some of the students take.

4. METHODOLOGY

A Microsoft Office skills class is a required course in the Bachelor of Business Administration program at a western U.S. public university. The course is also an elective in the general education program and is a required course in programs such as culinary arts, nursing, and sports administration. Approximately 70% of the students are majors in business disciplines.

Over eight semesters and one summer term, a pre-survey was conducted in the first week of several sections of a Microsoft Office skills class and a duplicate post-survey was administered in the last week. The survey contains questions about 97 Microsoft Windows and Office skills, each with the same 1-5 Likert Scale answers, anchored by "1. I have never done that" and "5. I have frequently done that." The questions on the survey are paraphrased in the 97 items in Table 1 (see Appendix). The surveys were not graded, but students received a few extra credit points for participating.

During those four years, 1062 students took the pre-survey and 786 students participated in the post-survey. The first number is roughly the count of students who enrolled in the class. The difference between the two counts is due to at least three factors. First, several students did not complete the class. Moreover, a few students are likely to have concluded that the points they receive for the post-survey at the end of the semester would not positively impact their grades. However, the biggest cause of the difference most likely was instructors forgetting to remind students to take the post-survey.

The survey was conducted on paper in the year prior to the start of this study. However, those results were not retained. In the first year of this study, some surveys were administered on paper, but most were administered via the university's web-based class support tools (WebCT & D2L). Survey data was stored in an Excel spreadsheet in order to produce the results displayed in the Appendix. Surveys done on paper were manually added to the Excel spreadsheets. Subsequently, data were analyzed in SPSS to determine significance at the .05 level.

To answer the fifth question, i.e., whether students retain skills from the first skills course to the next following course, a separate survey was conducted in the Spring 2012 semester in that follow-on course. Several questions were asked of 118 students at the beginning of the semester. Eighteen of those questions were measured on a Likert scale similar to the one on the pre-and post-surveys in the Microsoft Office skills course. Students also were required to take an entrance exam to demonstrate Microsoft Office skills. Those data were tabulated into an Excel spreadsheet and subsequently analyzed in SPSS to determine significance at the .05 level.

5. FINDINGS

General

From Figure 1 (see Appendix) one can see that students come into the Microsoft Office skills course with varying levels of knowledge in the differing categories of computer skills. That is also anecdotally reported to instructors of the Microsoft Office skills course. They know more about some aspects of using Windows, browsers, Word, and PowerPoint than they know about most aspects of Excel and Access. Even in the aspects where they have greater knowledge, their knowledge drops off as the specific skills become more advanced.

An important question to answer before statistical analysis is performed is whether the perception of the students in the first two years of the study regarding their Microsoft Office skills is statistically equivalent to the corresponding perceptions of students in the last two years of the study as measured by the pre-survey. Statistical equality would allow the researchers both to group the two sets of students together to compare pre- and post-survey scores and to separate the two groups in order to compare their improvement. This is important in answering some of the five research questions.

Those two groups of students were compared statistically. In Table 1 (See Appendix), the column labeled "C:E" compares the pre-survey scores of students in the first two years to those in the last two years. Of the 97 questions, only 10 had p-Value less than .05. Of those, only two questions were in the Microsoft Office groups, while the other eight questions dealt with Windows, browsers and file management. Those findings would indicate that the two groups of students' perceptions of their Microsoft Office skills prior to completing the course are similar. Therefore, the groups can be compared and combined in the subsequent analyses.

An important indication that one can infer from Figure 1 is that students' comfort level with Office skills decreases as the skills become more advanced. That is to say, students are more comfortable with simpler Excel skills than advanced ones. They are more comfortable with Excel skills in general than they are with most Access skills. These readings match the visual implications from Figure 2 which is based on the surveys in the follow-on computer skills class: If students were less capable with advanced Excel and most Access skills coming out of the Microsoft Office skills class, they should be expected to be similarly less comfortable going into the follow-on class.

Research Question 1

Also from Figure 1, the chart shows that students do indeed gain value from taking an Office skills course. Improvement is shown in a majority of the specific skills areas. This is encouragement that starts to answer the first research question in the affirmative. Greatest improvements are in shown in Excel and Access topics. However, none of the average scores rise to the level of 5 that the faculty desire.

Obviously, reliance upon visual clues from Figure 1 can be misleading. Thus these authors examined the data statistically to determine if statistical significance exists between the various pairs of means. The right-right hand columns of the eight pages of Table 1 show the result of statistical analyses of independent samples t-tests at a level of significance of $p < 0.05$.

The first of those right-hand columns in Table 1, labeled A:B, compares the responses of all pre-survey takers to the responses all post-survey takers which would be a potential indicator as to whether the computer skills course makes a difference in students' computer skill levels. On all 97 questions, there is a positive difference between pre- and post-survey means, indicating that students reported more comfort with skills on the post-test survey. All but five of these differences in average responses are statistically significant. That causes the authors to conclude that the computer skills course does indeed make a difference. Of course, the authors would prefer to see all the post-survey responses at a level of 5, but the results do indicate that the computer skills course is accomplishing its goals. This answers the first research question.

Research Questions 2 and 3

Columns C and D of Table 1 show the means for all pre- and post-survey takers prior to computer mediation, while columns E and F show those for students after computer mediation. For each of the two groups, C to D and E to F, there is a positive difference for all 97 questions when comparing the pre- and post-surveys. This means students reported more comfort on the post-test survey for each instruction method.

In the right-right hand columns of Table 1, the second (C:D) and third (E:F) columns give a similar pre-post comparison for those who took the course before it became computer mediated and after it became computer mediated. In the C:D column there are only five items for which the pre-post differences in the averages of student responses are not statistically significant. In the E:F column there are only six items for which the pre-post differences in the averages of student responses are not statistically significant. Those results cause the authors to conclude that the computer skills course accomplishes its goals and makes a difference in students' computer skills regardless of whether the course is computer mediated or not. This answers questions 2 and 3.
Interestingly, the timing of the transition to computer mediation corresponds to a state requirement that all high school graduates must take a computer skills course. It would appear that that rule might not have made a difference. However, the survey in this study was not designed to measure that and any formal conclusion is beyond the scope of this paper.

Research Question 4

The fifth (D:F) column compares the post-survey responses of prior to and after computer mediation. For more than half (53 of 97) of the items, there is a statistically significant difference in the post-survey responses for the two groups. In the case of 43 items, the students who took the course after computer mediation was added were statistically significantly higher than before computer mediation. Only 10 items had statistically significantly lower responses for the students who completed the computer-mediation.

A closer examination indicates that the computer mediation had higher means for the most advanced Microsoft Office skills level in the course. The authors do not believe that this is conclusive to answer question 4 in the affirmative. Although computer mediated instruction is more effective for the advanced skills, there is no definitive answer to the fourth research question that computer mediation does indeed make a difference in the delivery of a computer skills course. Further study is needed to conclusively answer this question.

Research Question 5

For indicators as to whether students retain information from a Microsoft Office skills course, one turns to Figure 2 (See Appendix). From the latter line chart, one can arrive at the following conclusions.

As would be predicted, those who never took the basic Microsoft Office skills course did less well on the entrance test and survey than the average for all students. Oddly, the averages of those who took the course prior to 1995 before it was truly a basic Microsoft Office skills course varied more than the average for all students. Since there are only four in that category, those

results are most likely meaningless. Since those four are non-traditional students who have been in the workforce for some time, on-the-job experience with Excel and Access probably trumps whatever they learned through courses.
For all but one question asked, those who took the basic computer literacy course after it became computer mediated rated their comfort level higher than those who took course before it was computer mediated. This is another positive indicator that computer mediation might help students to retain the computer skills from the early course. However, it might simply indicate that the skills have had less time to atrophy. Moreover, the small number of students in that category (21) renders the comparison as less reliable. Further data gathering and statistical analyses are warranted.

Figure 2 has lines not only for all 118 students but also for the 52 who did not take the basic Microsoft Office skills course, the 4 who took the basic course (CISB 101) prior to 1995 when the course was significantly different, the 39 who took the Microsoft Office skills course between 1996 and spring 2010 before it was computer mediated, and the 21 who took it in three semesters after it became computer mediated.

Table 2 presents the results of many independent samples t-tests performed on the data set ($\alpha = 0.05$). There were 108 total tests with nine of them resulting in statistically significant differences in the mean responses.

Column A compared to Column F yielded no difference between the students in the follow-on course (CISB 205) and students who took CISB 101 before 1996 (although n is extremely small for the latter set). This might indicate that students who took CISB 101 before 1996 have been using their skills in the workforce and are returning for more advanced skills training and/or to complete their degree.

Column B (students who took CISB 101 in the traditional format between 1996 and 2010) compared to Column F also showed no difference in the average response to the survey questions.

Column C (students who used computer mediated instruction) compared to Column F yielded a statistically significant difference in the survey result, the comfort level with Access. The students in the computer mediated class show a higher comfort level with Access than do the students overall (Column F). This indicates that the computer mediated class exposes the student to Access more than (on average) other teaching/learning experiences.

Comparing Column D (students who have never taken CISB 101) to Column F reveals one statistically significant result as well. Students who have never had CISB 101 know much less about Access than does the average student in CISB 205, which is to be expected.

Column E (all students who took CISB 101) compared to Column F illustrates that there is no significant difference between students who took CISB 101 and the students in CISB 205. This could be due to the effect of having the Column E student responses contained in the Column F responses.

Column D (students who never took CISB 101) compared to Column E (all students who took 101) reveals seven statistically significant differences in responses to survey questions. In fact, all students who took CISB 101 rated their familiarity and comfort with the Excel and Access tools higher than the students who never took CISB 101, but significant were: comfort with Access, 3-D cell referencing, relative cell references, conditional formatting, data filters, web page experience, and data tables. It appears that having CISB 101 before CISB 205 is advantageous for the students. This last result also verifies the claim made in the previous paragraph that having both groups in one sample has adverse effects on the results.

6. LIMITATIONS

There are several limitations on this study. First, the ideal situation would have been to perform paired samples t-tests, matching individual students' pre- and post-survey scores. However, that would have required collection of student identifying information which was not recorded when the survey was administered on paper. Therefore, that same practice continued through most of the study despite the student indentifying data being easily collected in the electronic survey instrument.

Second, employing a survey to ask students about their skills is not as desirable as directly measuring their skills. In future years, the latter might be employed via the computer-mediated software that was not available in the basic computer skills class when the study began.

Third, there are weaknesses in both surveys in terms of how some questions were asked. The wording was not precise for a few of the questions so the Likert scale anchor answers didn't quite match wording of some of the questions.

Fourth, there is concern as to whether students really know what some of questions mean until after they have taken the basic Microsoft Office skills course. Consequently, a few pre-survey answers might not be accurate, especially for more advanced skills. It is assumed that if students didn't know what the question means, the appropriate answer on the survey would have been "1. I have never done that."

Fifth, the study does not adjust for any confounding factors in order to reduce the bias that they produce. Examples of those other factors are difference in instructor teaching methods or in student demographics. Included is that there was a variable time lapse between students taking the Microsoft Office skills course and the follow-on course during which skills might atrophy.

Sixth, the use of a p-value of .05 to measure the differences between the first and second courses has been questioned by early reviewers who thought an alpha of .05 might produce many false positives. Closer examine of the p-Values given in Table 1 show that a large majority of the differences are statistically significant at the $p < 0.001$ level.

Seventh, these authors do not believe that the data can be generalized to a larger population. The data presented herein is useful and relevant to the authors in their assessment of the course in this study. However, the host institution is unique due to location, history, and the nature of the students that it attracts. Further study at other institutions of higher learning is needed to make a generalization to a larger population.

7. CONCLUSIONS

This paper has suggested that, in most aspects, students entering a college-level Microsoft Office skills course are no more skilled in personal computing in the last two years of the study versus the two years prior to that. Since their beginning skills are similar, the two groups were compared to conclude that the computer skills course does indeed make a difference in the student Microsoft Office skills level. Further, computer-mediated instruction blended with classroom instruction is more effective than traditional classroom instruction alone in building students' most advanced Microsoft Office skills in most categories of skills and for all Access skills. This paper has also shown that students who completed a basic Microsoft Office skills class are better prepared at the start of a more advanced computer skills course than those who did not take such a class. However, the findings suggest that computer-mediated instruction in the beginning Microsoft Office skills course made no difference in the students' preparation level for the more advanced course and the time lag between the basic Microsoft Office skills course and the advanced computer skills course is immaterial in terms of the students' readiness to take the advanced course.

This paper also points out many flaws of this study. While the findings are encouraging and beneficial for their intended course assessment purpose, they are not generalizable. The studies should be replicated using more refined data collection methods than opinion surveys. Computer mediated instruction could be used to administer pre- and post-tests (rather than surveys) that measure skills rather than attitudes. Such computer mediated measurement would not impact greatly on instructor workloads.

8. REFERENCES

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Appendix

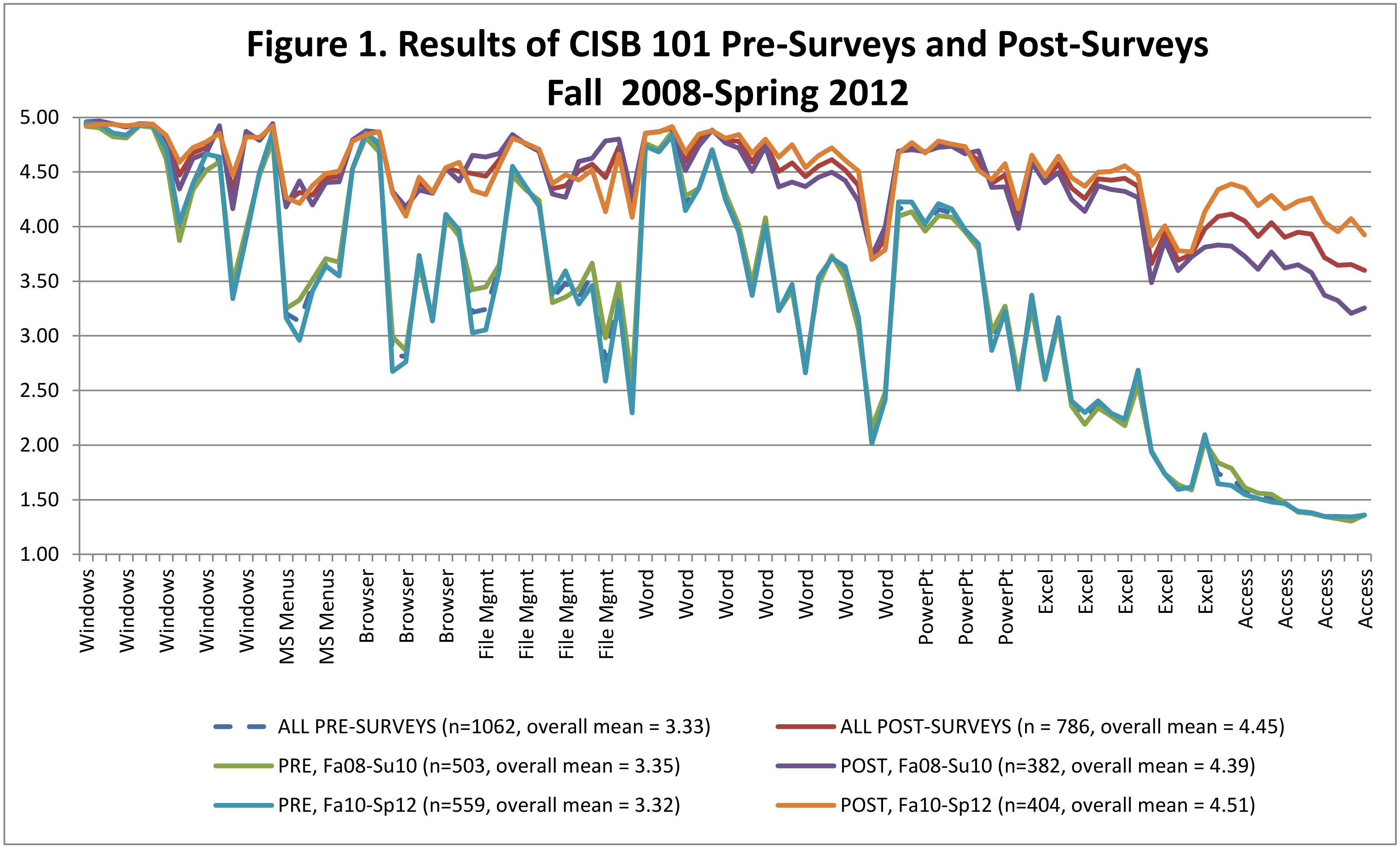
Figure 1. Results of CISB 101 Pre-Surveys and Post-Surveys
Fall 2008-Spring 2012
5.00
4.50
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File Mgmt
File Mgmt
File Mgmt
File Mgmt
Word
Word
Word
Word
Word
Word
Word
PowerPt
PowerPt
PowerPt
Excel
Excel
Excel
Excel
Excel
Access
Access
Access
Access
ALL PRE-SURVEYS (n=1062, overall mean = 3.33)
ALL POST-SURVEYS (n = 786, overall mean = 4.45)
PRE, Fa08-Su10 (n=503, overall mean = 3.35)
POST, Fa08-Su10 (n=382, overall mean = 4.39)
PRE, Fa10-Sp12 (n=559, overall mean = 3.32)
POST, Fa10-Sp12 (n=404, overall mean = 4.51)

Table 1. Means of Survey Questions and Analysis (page 1 of 8)

		A	B	C	D	E	F					
Survey Question #	Survey Questions	All Pre-Surveys	All Post-Surveys	Pre-Surveys Fa08-Su10	Post-Surveys Fa08-Su10	Pre-Surveys Fa10-Sp12	Post-Surveys Fa10-Su12	Statistically Significant at p < 0.001? For pairs of columns (Yes or Actual p-Value)				
N/A	N	1062	786	503	382	559	404	**A:B**	**C:D**	**E:F**	**C:E**	**D:F**
N/A	Overall means	3.33	4.45	3.35	4.39	3.32	4.51					
1	Turn the computer on and off.	4.94	4.94	4.92	4.96	4.95	4.92	.93	.10	.18	.15	.13
2	Open and close a program.	4.92	4.95	4.90	4.97	4.94	4.94	.07	.01	.97	.15	.19
3	Switch between several open programs.	4.84	4.94	4.82	4.94	4.86	4.94	Yes	Yes	.01	.28	.62
4	Resize and move windows	4.82	4.92	4.81	4.91	4.84	4.92	Yes	.01	.01	.49	.67
5	Use maximize, minimize, close buttons.	4.93	4.94	4.92	4.94	4.93	4.94	.51	.45	.83	.80	.79
6	Use the Start Menu.	4.92	4.94	4.91	4.94	4.93	4.94	.28	.24	.69	.39	.98
7	Find and open accessory programs.	4.67	4.79	4.62	4.74	4.71	4.84	Yes	.02	.01	.06	.03
8	Find topics in the Help menu.	3.96	4.47	3.87	4.34	4.04	4.59	Yes	Yes	Yes	.03	Yes
9	Use the Control Panel.	4.36	4.67	4.34	4.62	4.39	4.72	Yes	Yes	Yes	.39	.049
10	Change screen saver/desktop background.	4.59	4.72	4.51	4.67	4.67	4.77	.01	.01	Yes	.01	.05
11	Easily find files using My Computer.	4.62	4.89	4.59	4.92	4.64	4.86	Yes	Yes	Yes	.36	.04
12	Use Windows Explorer (not IE).	3.41	4.32	3.48	4.16	3.34	4.47	Yes	Yes	Yes	.11	Yes
13	Log onto your account and F: drive folder.	3.93	4.84	3.97	4.87	3.90	4.82	Yes	Yes	Yes	.35	.17
N/A	**All Windows questions**	4.53	4.79	4.51	4.77	4.55	4.82					

Table 1. Means of Survey Questions and Analysis (page 2 of 8)

		A	B	C	D	E	F					
Survey Question #	**Survey Questions**	**All Pre-Surveys**	**All Post-Surveys**	**Pre-Surveys Fa08-Su10**	**Post-Surveys Fa08-Su10**	**Pre-Surveys Fa10-Sp12**	**Post-Surveys Fa10-Su12**	**Statistically Significant at p < 0.001? For pairs of columns (Yes or Actual p-Value)**				
								A:B	**C:D**	**E:F**	**C:E**	**D:F**
14	Use the standard tool bar buttons.	4.49	4.80	4.47	4.79	4.50	4.82	Yes	Yes	Yes	.64	.51
15	Cut, copy and paste information.	4.83	4.93	4.79	4.94	4.87	4.92	Yes	Yes	.06	.03	.46
16	Know what "..." means in a menu.	3.20	4.22	3.25	4.18	3.16	4.27	Yes	Yes	Yes	.38	.29
17	Know what grayed-out command means.	3.13	4.31	3.33	4.42	2.96	4.21	Yes	Yes	Yes	Yes	.01
18	Add or remove buttons from toolbar.	3.46	4.29	3.51	4.20	3.41	4.38	Yes	Yes	Yes	.26	.02
19	Move toolbar to show buttons available	3.67	4.45	3.71	4.40	3.64	4.49	Yes	Yes	Yes	.45	.23
20	Display toolbars.	3.61	4.46	3.68	4.41	3.55	4.51	Yes	Yes	Yes	.14	.13
N/A	**All Microsoft menus questions**	3.77	4.50	3.82	4.48	3.73	4.51					

Table 1. Means of Survey Questions and Analysis (page 3 of 8)

		A	B	C	D	E	F					
Survey Question #	Survey Questions	All Pre-Surveys	All Post-Surveys	Pre-Surveys Fa08-Su10	Post-Surveys Fa08-Su10	Pre-Surveys Fa10-Sp12	Post-Surveys Fa10-Su12	Statistically Significant at p < 0.001? For pairs of columns (Yes or Actual p-Value)				
								A:B	C:D	E:F	C:E	D:F
21	Navigate the Web.	4.53	4.79	4.53	4.79	4.53	4.78	Yes	Yes	Yes	.99	.74
22	Find a specific web site using its URL	4.84	4.86	4.81	4.88	4.85	4.84	.39	.09	.71	.26	.33
23	Use keywords in a search engine.	4.73	4.87	4.68	4.86	4.76	4.87	Yes	Yes	Yes	.07	.88
24	Understand the four parts of a URL.	2.82	4.32	2.99	4.32	2.67	4.31	Yes	Yes	Yes	Yes	.82
25	Create a correct APA citation	2.81	4.14	2.87	4.18	2.76	4.10	Yes	Yes	Yes	.24	.14
26	Understand copyright laws on Web	3.70	4.40	3.66	4.33	3.74	4.45	Yes	Yes	Yes	.38	.08
27	Find scholarly articles using Library.	3.14	4.31	3.15	4.31	3.14	4.31	Yes	Yes	Yes	.92	.92
28	Bookmark pages; organize favorites.	4.09	4.54	4.07	4.53	4.11	4.54	Yes	Yes	Yes	.61	.90
29	Use Internet Options of a browser.	3.94	4.51	3.91	4.42	3.97	4.59	Yes	Yes	Yes	46	.01
N/A	**All browser questions**	3.84	4.52	3.85	4.51	3.84	4.53					

Table 1. Means of Survey Questions and Analysis (page 4 of 8)

		A	B	C	D	E	F					
Survey Question #	Survey Questions	All Pre-Surveys	All Post-Surveys	Pre-Surveys Fa08-Su10	Post-Surveys Fa08-Su10	Pre-Surveys Fa10-Sp12	Post-Surveys Fa10-Su12	Statistically Significant at p < 0.001? For pairs of columns (Yes or Actual p-Value)				
								A:B	C:D	E:F	C:E	D:F
30	The difference between drives.	3.22	4.49	3.42	4.65	3.03	4.33	Yes	Yes	Yes	Yes	Yes
31	The different types of drives.	3.24	4.46	3.45	4.64	3.06	4.29	Yes	Yes	Yes	Yes	Yes
32	Copy file from one drive to drive	3.62	4.61	3.65	4.67	3.59	4.56	Yes	Yes	Yes	.53	.048
33	Save files in a specific folder.	4.51	4.83	4.47	4.84	4.55	4.81	Yes	.09	Yes	.52	.37
34	Create folders and subfolders.	4.35	4.76	4.34	4.76	4.37	4.76	Yes	Yes	Yes	.65	.88
35	Identify files by their icons.	4.21	4.70	4.24	4.69	4.19	4.71	Yes	Yes	Yes	.48	.69
36	Determine the size of files.	3.35	4.35	3.30	4.30	3.39	4.39	Yes	Yes	Yes	.38	.18
37	Sort files by date or file type.	3.48	4.37	3.36	4.27	3.59	4.47	Yes	Yes	Yes	.01	.01
38	Understand a file pathname.	3.36	4.51	3.43	4.60	3.29	4.43	Yes	Yes	Yes	.13	.01
39	Access the download directory.	3.56	4.57	3.66	4.63	3.46	4.52	Yes	Yes	Yes	.02	.08
40	Turn in homework to your K:.	2.77	4.45	2.98	4.78	2.59	4.14	Yes	Yes	Yes	Yes	Yes
41	Use campus network acct & F:	3.39	4.73	3.48	4.80	3.31	4.66	Yes	Yes	Yes	.05	.01
N/A	**All file management questions**	3.61	4.57	3.66	4.64	3.53	4.51					

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Table 1. Means of Survey Questions and Analysis (page 5 of 8)

		A	B	C	D	E	F					
Survey Question #	Survey Questions	All Pre-Surveys	All Post-Surveys	Pre-Surveys Fa08-Su10	Post-Surveys Fa08-Su10	Pre-Surveys Fa10-Sp12	Post-Surveys Fa10-Su12	Statistically Significant at p < 0.001? For pairs of columns (Yes or Actual p-Value)) A:B	C:D	E:F	C:E	D:F
42	Use word-wrap to create paragraph.	2.42	4.18	2.56	4.28	2.30	4.08	Yes	Yes	Yes	.01	.02
43	Use italic, bold & underline format.	4.75	4.86	4.76	4.85	4.74	4.86	Yes	.02	.01	.56	.99
44	Double and triple space lines.	4.70	4.87	4.71	4.87	4.68	4.87	Yes	Yes	Yes	.63	.94
45	Use Spell Check.	4.85	4.91	4.87	4.90	4.83	4.92	.01	.01	Yes	.27	.67
46	Use Word's thesaurus.	4.21	4.60	4.28	4.51	4.15	4.68	Yes	.01	Yes	.10	.01
47	Create bulleted lists/numbered lists.	4.35	4.79	4.35	4.74	4.35	4.85	Yes	Yes	Yes	.96	.01
48	Change type face, color & size	4.70	4.88	4.70	4.88	4.70	4.88	Yes	Yes	Yes	.99	.90
49	Change right and left margins	4.27	4.79	4.31	4.77	4.25	4.81	Yes	Yes	Yes	.37	.33
50	Change the page layout.	3.98	4.78	4.01	4.72	3.95	4.84	Yes	Yes	Yes	.48	.01
51	Create a 2 or 3-column format.	3.42	4.59	3.47	4.51	3.37	4.67	Yes	Yes	Yes	.23	.01
52	Insert graphics and WordArt.	4.04	4.77	4.08	4.73	4.01	4.80	Yes	Yes	Yes	.35	.13
53	Create a multi-column table	3.23	4.50	3.23	4.37	3.23	4.64	Yes	Yes	Yes	.99	Yes
54	Insert, delete, move table rows.	3.44	4.58	3.42	4.41	3.47	4.75	Yes	Yes	Yes	.56	Yes
55	Use section breaks.	2.69	4.46	2.71	4.37	2.66	4.54	Yes	Yes	Yes	.58	.01
56	Center title page with one click.	3.50	4.55	3.47	4.45	3.54	4.65	Yes	Yes	Yes	.50	.01
57	Place automatic page numbers.	3.72	4.61	3.73	4.50	3.71	4.72	Yes	Yes	Yes	.80	Yes
58	Create a running header or footer.	3.59	4.52	3.53	4.42	3.63	4.61	Yes	Yes	Yes	.26	.01
59	Use style to create std headings.	3.12	4.38	3.06	4.23	3.17	4.51	Yes	Yes	Yes	.22	Yes
60	Automatically generate a ToC.	2.08	3.72	2.16	3.73	2.01	3.70	Yes	Yes	Yes	.09	.70
61	Create APA references list.	2.45	3.89	2.48	3.99	2.42	3.79	Yes	Yes	Yes	.46	.02
N/A	**All Word questions**	3.68	4.56	3.69	4.51	3.66	4.61					

Table 1. Means of Survey Questions and Analysis (page 6 of 8)

Survey Question #	Survey Questions	A: All Pre-Surveys	B: All Post-Surveys	C: Pre-Surveys Fa08-Su10	D: Post-Surveys Fa08-Su10	E: Pre-Surveys Fa10-Sp12	F: Post-Surveys Fa10-Su12	Statistically Significant at p < 0.001? For pairs of columns (Yes or Actual p-Value)				
								A:B	C:D	E:F	C:E	D:F
62	Play a slide show in Power Point.	4.16	4.68	4.09	4.69	4.23	4.67	Yes	Yes	Yes	.09	.72
63	Create slide w/ title & bulleted text.	4.18	4.74	4.14	4.70	4.22	4.77	Yes	Yes	Yes	.27	.17
64	Create slides with differing layouts.	4.00	4.68	3.96	4.69	4.03	4.67	Yes	Yes	Yes	.41	.82
65	Add, delete and move slides.	4.16	4.76	4.10	4.73	4.21	4.78	Yes	Yes	Yes	.17	.22
66	Insert pictures or clip art on slides.	4.13	4.74	4.08	4.73	4.16	4.75	Yes	Yes	Yes	.35	.68
67	Apply a slide background.	3.96	4.70	3.95	4.67	3.97	4.73	Yes	Yes	Yes	.84	.19
68	Use slide transitions.	3.82	4.60	3.80	4.69	3.84	4.52	Yes	Yes	Yes	.62	.01
69	Add auto page # to presentation.	2.95	4.40	3.04	4.36	2.87	4.43	Yes	Yes	Yes	.08	.30
70	Change font on slides using master.	3.25	4.47	3.27	4.37	3.22	4.58	Yes	Yes	Yes	.62	.01
71	Create automatic summary slide.	2.56	4.08	2.61	3.98	2.51	4.16	Yes	Yes	Yes	.28	.04
N/A	**All Power Point questions**	3.72	4.58	3.70	4.56	3.73	4.61					

Table 1. Means of Survey Questions and Analysis (page 7 of 8)

		A	B	C	D	E	F					
Survey Question #	**Survey Questions**	**All Pre-Surveys**	**All Post-Surveys**	**Pre-Surveys Fa08-Su10**	**Post-Surveys Fa08-Su10**	**Pre-Surveys Fa10-Sp12**	**Post-Surveys Fa10-Su12**	**Statistically Significant at p < 0.001? For pairs of columns (Yes or Actual p-Value)**				
								A:B	**C:D**	**E:F**	**C:E**	**D:F**
72	Find a particular cell and type into it.	3.32	4.62	3.26	4.59	3.37	4.65	Yes	Yes	Yes	.28	.23
73	Create correct equations, e.g., =A2*(B2+C2)	2.61	4.43	2.60	4.40	2.62	4.46	Yes	Yes	Yes	.85	.34
74	Insert, delete, move rows or columns.	3.14	4.57	3.11	4.50	3.17	4.65	Yes	Yes	Yes	.55	.01
75	Use fill handle to copy equations.	2.38	4.35	2.36	4.25	2.40	4.45	Yes	Yes	Yes	.62	.01
76	Use fill handle to create a sequence.	2.25	4.26	2.19	4.14	2.30	4.37	Yes	Yes	Yes	.22	.01
77	Use the AutoSum Function.	2.38	4.44	2.34	4.37	2.41	4.50	Yes	Yes	Yes	.49	.06
78	Use ranges in equations, e.g., (A1:A20).	2.28	4.43	2.26	4.34	2.29	4.50	Yes	Yes	Yes	.76	.01
79	Use summary functions, e.g., Min, Max, Avg.	2.21	4.44	2.18	4.32	2.24	4.56	Yes	Yes	Yes	.51	Yes
80	Create a simple bar or column chart.	2.62	4.37	2.55	4.27	2.69	4.46	Yes	Yes	Yes	.14	.01
81	Use powers, such as square root.	1.94	3.66	1.95	3.49	1.94	3.83	Yes	Yes	Yes	.86	Yes
82	Use absolute & relative referencing.	1.74	3.94	1.74	3.87	1.74	4.01	Yes	Yes	Yes	.97	.09
83	Use predefined functions, e.g., FV or PMT.	1.61	3.69	1.64	3.60	1.59	3.78	Yes	Yes	Yes	.51	.04
84	Create a correct IF statement.	1.60	3.75	1.59	3.72	1.62	3.77	Yes	Yes	Yes	.70	.59
85	Create advanced graphs and charts.	2.06	3.98	2.03	3.81	2.10	4.14	Yes	Yes	Yes	.43	Yes
N/A	**All Excel questions**	2.30	4.21	2.27	4.12	2.32	4.29					

Table 1. Means of Survey Questions and Analysis (page 8 of 8)

		A	B	C	D	E	F	Statistically Significant at p < 0.001? For pairs of columns (Yes or Actual p-Value)				
Survey Question #	Survey Questions	All Pre-Surveys	All Post-Surveys	Pre-Surveys Fa08-Su10	Post-Surveys Fa08-Su10	Pre-Surveys Fa10-Sp12	Post-Surveys Fa10-Su12	A:B	C:D	E:F	C:E	D:F
86	Open a report or form.	1.74	4.09	1.84	3.83	1.64	4.34	Yes	Yes	Yes	.01	Yes
87	Add, delete, change in table/form.	1.70	4.11	1.79	3.82	1.63	4.39	Yes	Yes	Yes	.04	Yes
88	Create a report or form.	1.58	4.05	1.61	3.73	1.55	4.35	Yes	Yes	Yes	.35	Yes
89	Understand relationship among tables	1.53	3.91	1.56	3.61	1.51	4.19	Yes	Yes	Yes	.44	Yes
90	Add fields to a table.	1.51	4.04	1.55	3.77	1.48	4.29	Yes	Yes	Yes	.27	Yes
91	Create table from field definitions.	1.47	3.90	1.47	3.62	1.46	4.16	Yes	Yes	Yes	.86	Yes
92	Execute a query.	1.39	3.95	1.39	3.65	1.39	4.23	Yes	Yes	Yes	.90	Yes
93	Create a simple field query.	1.38	3.93	1.37	3.58	1.38	4.26	Yes	Yes	Yes	.91	Yes
94	Incorporate summary fields in query.	1.35	3.72	1.35	3.37	1.35	4.04	Yes	Yes	Yes	.99	Yes
95	Incorporate a calculated field in query	1.34	3.65	1.33	3.32	1.35	3.95	Yes	Yes	Yes	.70	Yes
96	Create a main form with a subform.	1.32	3.65	1.30	3.21	1.34	4.07	Yes	Yes	Yes	.45	Yes
97	Create grouped report with headings.	1.36	3.60	1.36	3.26	1.36	3.93	Yes	Yes	Yes	.99	Yes
N/A	**All Access questions**	1.47	3.88	1.49	3.56	1.45	4.18					

Figure 2. Results of CISB 205 Pre-Surveys, Spring 2012

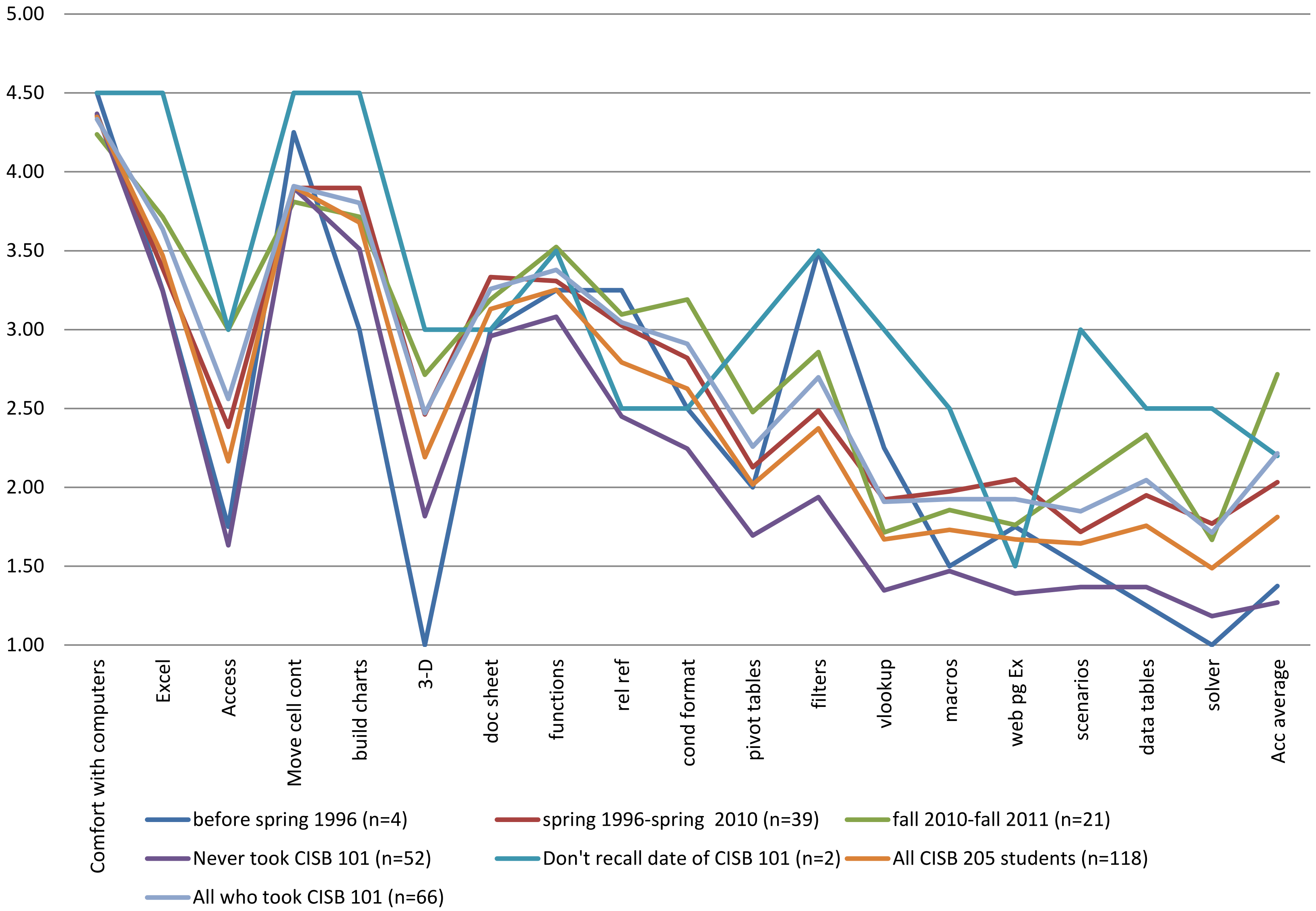

Table 2. Means of Survey Questions and Analysis in Follow-on Course

		A	B	C	D	E	F						
		Year when student took CISB 101				All who took CISB 101	All who took CISB 205	Statistically Significant at p < 0.05? For pairs of columns (Yes/No)					
Survey Ques tion #	Survey Questions	Before 1996	Spring 1996-Spring 2010	Fall 2010-Fall 2011	Never			A:F	B:F	C:F	D:F	E:F	D:E
	n	4	39	21	52	64	116						
1	Comfort w/ computers	4.50	4.36	4.24	4.37	4.33	4.35	No	No	No	No	No	No
2	with Excel	3.25	3.39	3.71	3.24	3.64	3.47	No	No	No	No	No	No
3	with Access	1.75	2.38	3.00	1.63	2.56	2.17	No	No	Yes	Yes	No	Yes
4	move cell cont	4.25	3.90	3.81	3.90	3.91	3.90	No	No	No	No	No	No
5	build charts	3.00	3.90	3.71	3.51	3.80	3.68	No	No	No	No	No	No
6	3-D	1.00	2.46	2.71	1.82	2.47	2.19	No	No	No	No	No	Yes
7	doc sheet	3.00	3.33	3.19	2.96	3.26	3.13	No	No	No	No	No	No
8	functions	3.25	3.31	3.52	3.08	3.38	3.25	No	No	No	No	No	No
9	rel ref	3.25	3.03	3.10	2.45	3.05	2.79	No	No	No	No	No	Yes
10	cond format	2.50	2.82	3.19	2.24	2.91	2.63	No	No	No	No	No	Yes
11	pivot tables	2.00	2.13	2.48	1.69	2.26	2.02	No	No	No	No	No	No
12	filters	3.50	2.49	2.86	1.94	2.70	2.37	No	No	No	No	No	Yes
13	vlookup	2.25	1.92	1.71	1.35	1.91	1.67	No	No	No	No	No	No
14	macros	1.50	1.97	1.86	1.47	1.92	1.73	No	No	No	No	No	No
15	web pg Ex	1.75	2.05	1.76	1.33	1.92	1.67	No	No	No	No	No	Yes
16	scenarios	1.50	1.72	2.05	1.37	1.85	1.64	No	No	No	No	No	No
17	data tables	1.25	1.95	2.33	1.37	2.05	1.76	No	No	No	No	No	Yes
18	solver	1.00	1.77	1.67	1.18	1.71	1.49	No	No	No	No	No	No