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An Observational Study of Peer Learning for High School Students at a Cybersecurity Camp

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Abstract

This paper reports on the design and implementation of a cybersecurity camp offered as a cybersecurity learning experience to a group of female and male high school students. Students ranged in grade level from freshmen to senior. Student demographics, including any existing pre-requisite knowledge, were unknown to camp designers prior to the start of the camp. Such unknowns presented five design constraints that required lateral solutions to address. Chiefly, a peer learning design was deployed that allowed participants to self-organize and autonomously explore learning within secure systems administration, network security, and cryptography. Furthermore, camp participants were provided with three objects to guide the peer learning objective: a booklet containing fundamental commands within the camp knowledge areas, a Xubuntu virtual machine as a digital playground, and a digital scavenger hunt game to reinforce acquired knowledge. Observational data indicate that peer learning was a successful pedagogy. Further, the results demonstrate compelling knowledge and behavioral flows amongst participants. Accordingly, this paper goes on to suggest a Community of Practice (CofP) as an organizational umbrella to support ongoing peer learning in the cybersecurity field. The paper also calls for future research to support the development of peer learning and CofP structures to support cybersecurity education.

Keywords: Cybersecurity, education, instructional design, peer learning, virtual machine, community of practice

1.INTRODUCTION

The cybersecurity field is in a phase of explosive growth yet the news of cybersecurity exploits and resultant damage continues to dominate stories of cybersecurity success. The education community has responded with a host of related academic programs that have met with varying levels of success. In general, however, it appears that the improvements in cybersecurity education are falling short of industry demands. In fact, improvements in cybersecurity education may even be falling short of the pace of change in industry meaning that despite improvements we are falling further behind each year in meeting the needs of industry.

There are two sets of challenges for cybersecurity educators. The first of these challenges is output; we are failing to provide the number of cybersecurity professionals needed. Further, graduates lack the required depth in cybersecurity knowledge and skills as well as experience in lifelong learning to sustain careers in this fast-paced and ever-changing field. According to Kevin Mandia, a leading voice in the cybersecurity field, new entrants to the cybersecurity field require seven years of on-the-job training before attaining a sufficient skill set to perform the duties of an information security professional (Marsh, 2012). This suggests that even the modest number of individuals trained in cybersecurity still lack the depth in skills needed to reach a productive status in a reasonable timeframe.

The second set of challenges revolves around inputs and the fact that there are too few incoming students. There is also debate as to whether the scaling efforts in academia are effective in supporting increased participation in programs. Such scaling efforts as flipped classrooms, laboratory exercises, and cybersecurity competitions struggle to accommodate mixed skill level groups with high unknowns in demographics such as age, gender and academic preparation.

The challenges in the cybersecurity field are rooted in technological and social factors that are in a state of constant development and change. As a result, cybersecurity education is partially driven by technical skills that can often be taught in an objectivist fashion, and problem solving skills that typically require a constructivist approach. Preparing students for the cybersecurity field is complicated by the array of complex topics that are represented in the field and the differing learning processes that effectively support the topics.

This paper reports on a cybersecurity camp with a focus on the inputs to cybersecurity education. The cybersecurity camp included students entering grades 9 – 12. The purpose of this observational case study was to describe the implementation of peer learning in a cybersecurity camp as a means of addressing a diverse participant sample with high-unknown academic preparation and demographics. The study may be significant for educators interested in hosting similar, STEM-based camps. As well, the results might be of interest to researchers investigating communities of practice and student-driven group dynamics within knowledge acquisition paradigms.

2. METHOD

An observational research design permitted study of participant behavior in a realistic setting (McBurney& White, 2008). As well, an observational design was appropriate as there were no pedagogical influences or treatments applied to participants (Watt & van der Berg, 2002). Further, an observational design enabled passive data collection with the goal of answering a single research question that guided the study: *how can peer learning be implemented in a cybersecurity camp when there are a high number of participant unknowns*. Accordingly, the underlying design of the cybersecurity camp targeted five primary elements.

Cybersecurity Camp Design

Design of the cybersecurity camp began approximately one month before the opening date. Design considerations included possible constraints as well as overarching goals. Design of the cybersecurity camp was constrained in five ways. Fortunately, these constraints were known before development of the camp materials. Consequently, the design of the camp included compensating features to eliminate as many undesirable learning outcomes as possible.

Design constraints

The first constraint was that the camp sponsor limited potential learning objectives to a short but broadly defined set of knowledge concepts. Limiting the learning objectives was necessary as the sponsor had scheduled additional cybersecurity camps in the near future and, as such, a number of popular learning objectives were already allocated to other institutions. Thus, the resultant design was limited to three learning objectives considered by external sources (National Information Assurance Training and Education Center, n.d.; The National Initiative for Cybersecurity Education, n.d.) as *fundamental*. In fact, as the other design constraints emerged, the importance of selecting *general* learning objectives was made more apparent. Accordingly, the learning objectives selected were secure systems administration, network security and cryptography. These learning objectives were fundamental and were considered broad enough to provide flexibility in the pedagogy for a variety of participant knowledge and skill levels.

The second constraint was the time limits associated with the camp. One time limit existed as the total number of days. Another time limit existed as the total number of hours for each day. Five days in total were allotted for the camp. However, one day was consumed for a field trip to the National Cryptologic museum while the final day was filled with closing ceremonies. The camp hours started at 9AM, and ended at 2PM. A mandatory one-hour lunch break left approximately four hours, per day, available for learning activities. These times functioned as limitations due to (a) forced scoping of knowledge material such as handouts, presentations or games; (b) the third constraint.

The third constraint was that the total number of participants was unknown prior to the camp start. Another department conducted marketing and registration. Throughout the open enrollment period, it was unclear how many community colleges had been contacted and how many students had registered.Thus, a prime design consideration was the scalability of the camp design. Both the pedagogy and the learning materials (in scope, form and function) needed to operate identically at any camp size. The danger of having too little material for the group is that participants could become bored and uninterested. On the contrary, the danger of too much material for the group is that participants could become overwhelmed and, as a result, disengaged. Naturally, the camp material needed to accommodate the average skill level of participants and be age-appropriate.

The fourth constraint was that the individual skill level of students was unknown. Knowing the average skill level of participants proved impossible without knowing the registration demographics. Accordingly, an assumption was made that participants would possess a range of skill levels with the majority possessing little knowledge in the specific topics covered in the cybersecurity camp. Yet, despite such an assumption, both the pedagogy and learning materials needed to equally serve students of low, medium, and high skill levels.

The fifth and last constraint was student gender, age, and grade level. When design of the cybersecurity camp began, the gender, age and grade level of participants were unknown. The registration process did collect such information but, due to limitations in the registration process, could not communicate the data in advance of the first camp session. As a result, the camp design necessitated incorporation of materials that would be gender, age, and grade appropriate across an array of categories.

Design goals
Based on the design constraints, five goals were established to anchor the design for the cybersecurity camp. First, peer learning would serve as the overarching pedagogy. Second, open workbooks would be used for each of the three learning days. Third, participants would have access to a Linux virtual system during the learning camp days. Fourth, each learning day would include *playtime* wherein camp participants would engage in a digital scavenger hunt. Lastly, a final presentation would reveal emergent learning concepts and afford participants the opportunity to provide overall feedback.

Peer learning
Selecting an appropriate learning theory is critical to establishing pedagogical techniques (Hill, 2002) becausethe enveloping learning theory creates a structure within which educators and learners frame knowledge.Objectivist pedagogy was not appropriate because of the high level of unknowns (Duffy &Jonassen, 1992; Jonnassen, 1991). Moreover, according to (Kaucher& Saunders, 2002), cybersecurity pedagogy should be *active*.

Peer learning was selected as the overarching pedagogy for the cybersecurity camp. Based on research (King, 2002; O'Donnell & King, 1999), peer learning was most appropriate to best compensate for the design constraints. Other constructivist pedagogies were not deemed appropriate. While consideration was given to hands-on learning via laboratory exercises, existing research demonstrated that learners do not view lab exercises as active (Pittman & Barker, 2014). Likewise, consideration was given to a pure game-based learning solution. However, game-based learning would require understanding learner skill-level ahead of the design phase if used in isolation (Prensky, 2001). Remaining constructivist pedagogies would alsonot be able to address the constraints on the camp (Moallem, 2001).

Open booklet to guide peer learning
Textbooks are objectivist in design and implementation (Keller, 2007). Thus, employing a static source of (written) knowledge would be incongruent to an implementation of constructivist peer learning. Instead, participants were provided with a medium conducive to acquisition of dynamic knowledge.

Aligned with the design goals, we furnished three booklets to all cybersecurity camp participants (examples in Table 1). The booklets were organized according to the learning goals of the cybersecurity camp: secure systems administration, network security, and cryptography. Each booklet contained an outline structure consisting of headings and knowledge points associated with the cybersecurity topic for that day.

Virtual system to explore the booklet topics
Providing a *playground* of sorts was a primary design objective for the cybersecurity camp. Digital playgrounds have been found to be motivational, competence building, and confidence enhancing (Bers, 2012; Majgaard, &Jessen, 2009). Further, pedagogical tools

operating in this context are *active* constructivist instruments.

Secure Systems Admin.	**Network Security**	**Cryptography**
Moving Around	*Moving Around*	*Did It Change?*
cd	ftp	md5
mv	ssh	sha
cp	telnet	
Working With Files	*Working with Files*	*Working with Files*
ls / ls -a	tcpdump	gpg
type	ngrep	openssl
find		
grep		
Note: Italicized phrases represent headings from booklets while non-italicized words represent knowledge points.		

Table 1. *Examples of booklet headings and associated knowledge point content*.

Prior research (Pittman & Barker, 2014) established that laboratory exercises are described as objectivist in use. Accordingly, employment of the virtual systems as a companion pedagogical device to the overarching peer learning strategy required avoidance of common laboratory exercise corpora. In lieu of laboratory exercises, camp participants were encouraged to use the virtual system as an exploratory tool.

Game to reinforce peer learning

While not adequate if used alone, a game-based learning solution in conjunction with the other design goals had the potential to bolster knowledge acquisition (Prensky, 2001). Specifically, a scavenger hunt type game would give access to group play that would be internally adaptable to changing player skill (Prensky, 2001).Thus, the digital scavenger hunt consisted of 20 puzzle items, discoverable and solvable within a Xubuntu Linux virtual machine (examples in Table 2). The virtual machine was the same used during the peer-based knowledge discovery phases of the cybersecurity camp. However, access to the game portion of the cybersecurity camps occurred under a discrete login. Thus, participants' work during the playground phase each day was not accessible during game time and vice-versa.

The scavenger hunt puzzles were intended to appeal to a broad array of participant skill levels as well as to different genders. Each item required multiple steps to solve (i.e., find the correct answer). Requiring multiple steps permitted (a) an overarching trial-and-error approach and (b) all skills levels to work on the same item instead of maintaining different items for different skills levels.

Learning Goal	Clue
Secure Systems Administration	Sometimes things are that Hidden are not so hidden after all. Like an inception, there can be many layers. See if you can retrieve the password from the not so hidden.
Network Security	Fred is reliable. So reliable in fact, we were able to capture Fred logging into FTP. Can you figure out Fred's password?
Cryptography	You are stuck in the Matrix. To establish a line and call out to your operator, you need to find the key and determine the type of cipher used. Only then will you be able to rejoin the resistance.

Table 2. *Examples of scavenger hunt puzzle clues*

Participants were encouraged to work in groups and to use the knowledge captured in the booklets. Knowledgeable staff members were available to *guide* camp participants. Guidance was restricted to broad discussions of concepts and demonstrations of similar techniques. At no time were answers provided.

Presentations to convey learned concepts

The final design goal mapped to constructivist principles (Partlow& Gibbs, 2003) and provided an opportunity for cybersecurity camp participants to exercise creativity. Furthermore, presentation of cybersecurity knowledge acquired during the camp, from a pedagogical standpoint, was designed to reinforce secure systems administration, network security, and cryptography concepts that participants found meaningful. To that end, participants received a presentation template containing broad instructions. The instructions outlined the mandatory content for the presentation (four questions) but allowed participants to modify the visual content in any manner they felt necessary.

3.RESULTS

The camp started with 27 students. Two students withdrew after the first day. Twenty-five students remained for the balance of the cybersecurity camp with full participation. Remarkably, 36% of camp attendees were female, an outcome that exceeds the typical STEM ratio of 80% male to 20% female (Beede et al., 2011). Further, a high number (40%) were non-seniors with 20% being true underclassmen (e.g., sophomore and freshmen). Figure 1 illustrates the distribution of participants by gender and grade level.

Each day, participants were allotted three hours to explore the booklets and engage in peer learning activities. Activities included group discussions, informal research, and trial-and-error practice within the same virtual machine housing the scavenger hunt. There was minimal intervention from camp staff. When necessary, assistance from staff was limited to conceptual explanations or short technical demonstrations.

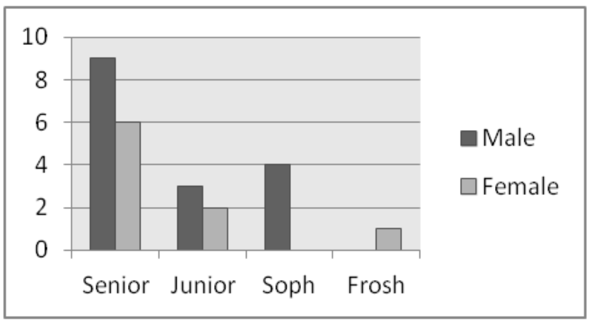

*Figure 1.*Distribution of high school student participants in the cybersecurity camp according to grade level and reported gender.

Peer Learning as Main Pedagogy

Observationally, four participants demonstrated high levels of proficiency in the camp topics. The four, highly proficient participants were not all seniors however, nor all male. Two were seniors, one was a junior and one was a sophomore. One of the junior grade level participants was female.

Figure 2 illustrates the flow of peer learning amongst participants. The four high proficiency participants emerged as focal points of knowledge for other participants. Organically, participants of moderate proficiency were observed to engage highly proficient attendees on a frequent basis. Both sides of the engagement appeared to benefit from those exchanges. Further, as the moderately proficient participants identified meaningful concepts or solved scavenger hunt puzzles, those attendees were observed to engage the less proficient participants. Thus, the moderately proficient participants served as conduits or brokers of information between highly proficient and less proficient attendees. Periodically, highly proficient participants would organize the attendees in the immediate physical area and demonstrate a new technique or knowledge concept.

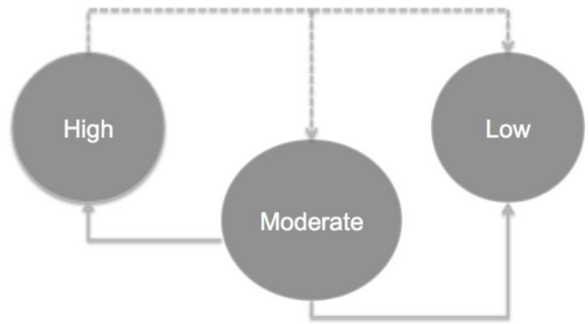

*Figure 2.*The flow of peer learning knowledge transfer between participant proficiencies.

Open Booklet to Guide Peer Learning

The open booklets appeared to be beneficial but in an unanticipated manner. The intention was for participants to add individually or group synthesized knowledge to each command in the booklets. In effect, each booklet could have turned into an approximated textbook. However, participants instead turned the booklets into what is best described as *concept maps* (Mintzes, Wandersee, & Novak, 2000).

Participants diagrammed relationships between commands within each booklet. These mappings, observationally, stemmed from knowledge acquired through group discourse. Such led to the ability for participants to sequence commands in a meaningful way during the virtual system or scavenger hunt camp phases for the respective days. As well, participants diagrammed command parameters or options across all commands within each booklet. In doing so, participants demonstrated the capacity to reuse newly synthesized knowledge.

Virtual system

Those participants that opted to work in peer groups were observed using the Xbuntu Linux system as a dynamic, ad-hoc laboratory system. While there were no pre-canned laboratory exercises included in the camp, participants organically derived a means of trial-and-error within the boundaries of collective peer knowledge. Further, the peer groups appeared to exercise a high degree of diligence in use of the open booklets to record the trial-and-error behavior. Collectively, these behaviors were consistent with the dynamics of peer learning and, observationally, appeared to facilitate knowledge acquisition and, perhaps more importantly, stimulated learning while being *fun*.

Further, knowledge gained during this phase appeared to be fed back into the open booklets. A model of such observed participant behaviors can be found in the appendix.

Presentations to Convey Concepts Learned

Participants closed out the week by presenting a summary of (a) the top cybersecurity ideas learned during the camp; (b) what camp activity was the most fun; (c) what the participant's were most proud of; (d) what area of cybersecurity they wanted to know more about; and (e) what scavenger hunt item was the peer group favorite. A content-less PowerPoint slide deck was provided as a functional outline but participants were free to modify the slide deck.

Participants self-organized into four groups that reflected the peer learning relationships established during the prior days. Each group had 15 minutes to present the group's responses (Table 2). Qualitative data, collected during, and as part of, the participant presentations were analyzed according to four thematic dimensions. Content analysis was used to mine the majority and minority perceptions within each thematic dimension.

Thematic Dimensions	**Participant Perceptions**	
	Majority Perception	*Minority Perception*
Cybersecurity Ideas Learned	Linux security	Cryptography
Most Fun Activity	Scavenger hunt	Field trip
Proudest Achievement	Linux security	Cryptography
Future Interests	Cyber attack	Cryptography

Table 3. *Participant perceptions of the CyberSTEM camp*

4.FUTURE RESEARCH

Extending the peer learning activities discussed in this paper is a daunting task. The time required to assess students learning and achievement, determine curricular supports and then deliver such curricular supports is time consuming, even in a scenario where students are doing much of the work in supporting their peers. A quick look at teams of students needing such support shows nearly 3,000 high school teams in the CyberPatriot program. Alone.CyberPatriot is only one of many cybersecurity programs at the high school level and is currently extending to middle school as well. College students in competitions such as CSAW, (Cyber Security Awareness Week) CCDC, (Collegiate Cyber Defense Competition) NCL, (National Cyber League) and ISEAGE CDC need support as well. There are tens of thousands of cybersecurity participants in need of learning support materials/activities and the numbers of such participants are growing rapidly each year.

Lave and Wenger (1991) challenged the notion that learning is the reception of knowledge and posited learning should include participation in a Community of Practice (CofP). Such communities, we believe, offer an opportunity for students to drive their own learning therefore requiring significantly less external supports. Lave and Wenger go on to call for engaging a person's intention to learn and that learning is configured as one becomes a full participant in the process. Eckert and McConnell-Ginet(1992) summarize Lave and Wenger and provide the following definition of CofP:

"An aggregate of people who come together around mutual engagement in an endeavor. Ways of doing things, ways of talking, beliefs, values, power relations – in short, practices – emerge in the course of this mutual endeavor. As a social construct, a CofP is different from the traditional community, primarily because it is defined simultaneously by its membership and by the practice in which that membership engages." (1992, p. 464)

Communities of practice are a relatively recent construct though this type of activity has been occurring since the dawn of time. It's easy to see ways that these concepts have been used for hundreds of years in medicine and many other fields. Recent publications regarding CofPs have stemmed from language development (Holmes & Meyerhoff, 1999) medicine (Ranmuthugala et al., 2011) and many others.

A benefit of using CofPs in the development of cybersecurity learners is that such learning patterns will benefit students throughout their career. It is clear from existing literature that CofPs in cybersecurity education will require unique attributes that must be developed. Particular attention must be paid to topics such as ethics and privacy which are loosely defined constructs that routinely require redefinition due to continual pressure from both technological and societal forces.

While this paper proposes the use of CofP's to support peer learning we believe there is a strong case for the use of CofP's with any teaching/learning style that involves the co-creation of knowledge. Even with traditional teaching methodologies CofP's could be used to bring students together to create and maintain a wiki that contains the vocabulary of a course which will include students in defining the knowledge base.

Teaching methods that include students more directly in the formation and dissemination of knowledge have even greater opportunities to engage students through CofP's. For instance, the use of CTF games, cyberwar style competitions and peer learning place students in the center of knowledge production and place instructors in the role of mentors and guides. Such environments can potentially leave students floundering, however, the addition of CofP's offer students an opportunity to support one another in meeting these enhanced learning challenges. Furthermore, developing CofP's among students in school will potentially lead to CofP's in industry allowing cybersecurity practitioners to develop their field in a manner consistent with medicine and law where CofP's have been active for many years.

5. CONCLUSION

This study reported on an implementation of peer learning in the context of high school cybersecurity camp participants. The implementation leveraged five, broad design goals to overcome a high number of participant unknowns (chiefly, demographics and knowledgebase). The design included an overarching pedagogy vis-à-vis peer learning, open booklets containing fundamental commands and concepts within secure systems administration, network security, and cryptography knowledge domains. The design also included an Xbuntu Linux-based system that housed both a workspace for participants as well as a digital scavenger hunt game. An observational research design was employed to record participant interactions and behaviors relative to the design goals.

Results were positive and encouraging. Cybersecurity camp participants universally reported an increase in secure systems administration, network security, and cryptography knowledge. Overall, the peer learning strategy was successful as overall learning objectives were achieved largely because participants that were more proficient served as knowledge loci for less proficient participants.

The open booklets were useful, albeit in an unintended fashion as students used the booklets to create process maps and relationship diagrams as opposed to documenting facts in more traditional textbook fashion. Participants' appropriation of the booklets is perhaps one of the most interesting and important takeaways from the camp, as it seems to indicate their preference for making sense of knowledge in the domain.

The scavenger hunt game was the most frequently praised aspect of the camp. Peer learning, active learning and game-based learning converged in a manner conducive to participant knowledge acquisition and fun. Presentations on the final day appeared to be the second most fun part of the cybersecurity camp next to the scavenger hunt. The engagement levels made possible by the games and the peer learning context in which the games were played positively impacted learning.

6. RECOMMENDATIONS

Based on the observational results, there are three recommendations for future research. First we call for an investigation on ways that learning achievements can be quantified and recorded. Although participants reported an increase in cybersecurity knowledge, such was not quantified in this study. Future research investigating the quantitative shift in participant knowledge may be of interest to educators, researchers, employers and event designers.

Second, we call for research that explores the use of CofPs in cybersecurity and defines attributes for CofPs that are best suited to this field of study. The varying roles within cybersecurity range from topics such as privacy and ethics to technical topics such as computer networking, operating systems and hardware/software design. As such, CofPs in cybersecurity must represent a broad range of diverse topics and learning styles.

Finally, we call for research investigating the relationship between peer learning and CofPs. We posit that CofPsare an effective umbrella organizational structure to foster peer learning in cybersecurity. Such CofPs will have participants ranging in age from middle school to veteran professionals and research must examine the details of how existing expertise, age, grade level and gender may contribute to efficacy of peer learning. Individuals must enter new peer learning groups and transition between groups as their interests and external motivations cause them to venture between areas of study. CofPs must offer support mechanisms that provide an organizational umbrella over the many peer-learning groups in the field and empower the process of transitioning between peer learning groups as needs and interests emerge.

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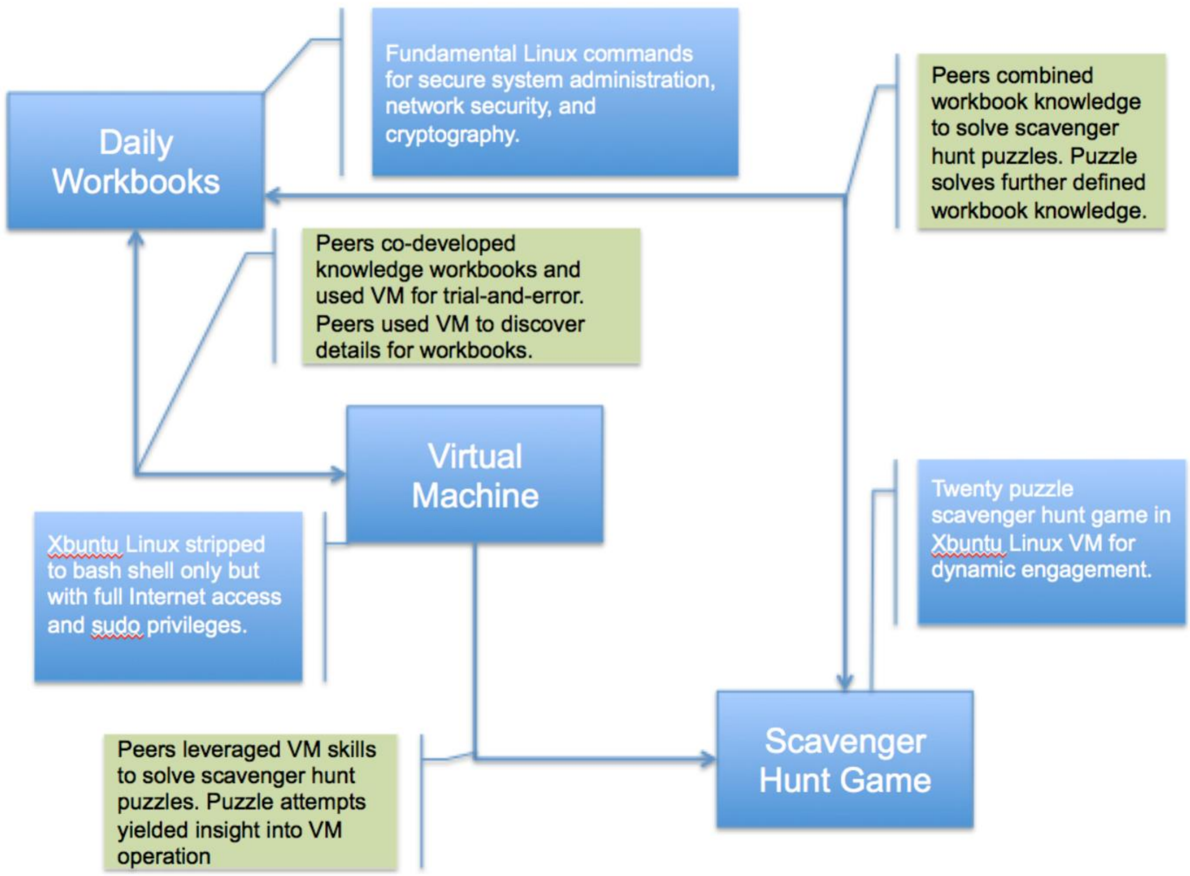
Appendix

Model of Observed Participant Behaviors Associated with Key Peer Learning Inputs



Facebook's Effect on Learning in Higher Education: An Empirical Investigation

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Abstract

Due in part to its widespread acceptance, Facebook has been adopted as a tool for higher education courses. Proponents claim that Facebook-enhanced courses facilitate an increased community of practice, sense of learning and sense of connectedness compared to non-enhanced courses. This empirical study uses a survey methodology in an independent measures static group comparison research design to compare the responses of 586 students who were enrolled in Facebook-enhanced business courses with those who were not. The courses were taught by two instructors at two different universities in the USA. The use of Facebook in students' courses serves as the independent variable. Students' attitudes toward the community of practice, sense of learning and sense of connectedness that evolved in their classrooms serve as the dependent variables. Research findings show that students in the Facebook-enhanced courses experienced a somewhat more positive community of practice, sense of learning and sense of connectedness compared to students in non-Facebook-enhanced courses. Implications for teaching, limitations and further research are discussed.

Keywords: Facebook, Social Networks, Technology in Higher Education Classrooms, Sense of Classroom Community, Sense of Learning, Sense of Connectedness, Community of Practice

1. INTRODUCTION

Many collegiate educators believe that online social networks have enormous potential to shape the way humans learn (Bosch, 2009; Harris & Rea, 2009; Ractham, Kaewkitipong, & Firpo, 2012). They believe that capitalizing on the social nature of online networks can create an optimal environment for learning to occur (Hung & Yuen 2010), given that today's students learn about computers, software and network technologies at an early age. Those students are primarily "digital natives" (Prensky, 2001) who are comfortable with technology even before they enroll in their first university course. The higher education community has made great strides in utilizing technology infrastructure, yet the pedagogical implications remain vastly unexplored (Hemmi, Bayne, & Land, 2009).

The ubiquity of social networking media is no more apparent than at universities where social media, including Facebook, are steadily transforming education and the way most subjects are taught (Tess, 2013). Because social media are interactive, participants can create, edit or share information. Unlike traditional one-way media such as television, social media are two-way conversations in which control is decentralized and open to masses of users (Barczyk & Duncan, 2012). Consequently, faculty are becoming less the authoritative deliverers of knowledge and more the facilitators of exploration and collaboration in pursuit of answers and solutions to problems. Some higher education faculty view Facebook and other social media as a way to motivate and engage students to be actively involved in their learning (Junco, Heiberger, & Loken, 2011).

Facebook has the potential to become an exciting instructional tool given its popularity and students' familiarity with its site. In fact, it has the potential to influence students in the United States and globally. Because 80% of Facebook's 1.55 billion monthly active users live outside the United States (Facebook, 2015), it represents a global, engaging information-sharing mechanism that can facilitate critical thinking and intercultural dialogue (Maher & Hoon, 2008). Research suggests that Facebook's focus on peer-to-peer interactions enhances informal learning experiences (Goodwin, Kennedy, & Vetere, 2010; Madge et al., 2009; Selwyn, 2009). Other studies have shown that students have effectively used Facebook for learning and activism (Bosch, 2009; Grosseck, Bran, & Tiru, 2011).

While students' use of Facebook is well documented, research demonstrates that faculty members have also utilized it for academic purposes. Junco (2012) reports that faculty are using social media sites for course-related purposes and that usage is rapidly increasing. However, some college educators are hesitant to embrace Facebook as an instructional tool (Moran, Seaman, & Tinti-Kane, 2011; Roblyer, McDaniel, Webb, Herman, & Witty, 2010). A study by Kirschner and Karpinski (2010) reported that student users of Facebook had significantly lower grade point averages than non-users; and they spent fewer hours per week engaged in study compared to non-users. In sum, the current research suggests that Facebook is a promising, but not a perfect, educational tool that warrants further application and study.

The primary purpose of this paper is to discuss the results of a study designed to determine whether the incorporation of Facebook into the instructional design of business courses has an impact on students' attitudes and perceptions of those courses. Specifically, students' perceptions of the classroom community of practice (CoP) established in their Facebook-enhanced courses will be compared to students' perceptions of the CoP in non-Facebook-enhanced courses. Additionally, whether students in Facebook-enhanced courses perceive a different sense of classroom community (SCC) from those in non-Facebook-enhanced courses will be analyzed.

Organizationally, this paper is divided into four parts. The first reviews the literature and formulates three research questions. The second describes the methodology used to address the research questions and begins with a description of how the classroom CoP was created using Facebook. The third summarizes the findings associated with the research questions. The fourth discusses the conclusions and limitations of this study, and areas for future research.

2. REVIEW OF THE LITERATURE AND FORMATION OF RESEARCH QUESTIONS

Attitudes toward using Facebook in the classroom

The earliest definition of attitude is provided by Allport (1935) who indicated that it is a neural or mental state of readiness, which is organized through experience and exerts a directive influence on the individual's response to all objects and situations to which it is related. Pickens (2011) defines an attitude very simply by stating that it is a mindset to act in a certain way due to both an individual's experience and temperament. Attitudes help define how people see situations and how they behave toward them. When reference is made to a person's attitudes, it is an attempt to explain his or her behavior. Attitudes are a complex set of things sometimes called personality, beliefs, behaviors, values, and motivations.

Perceptions are closely related to attitudes. Lindsay and Norman (1977) indicate that perception is a process wherein organisms interpret and organize sensation to produce a meaningful experience of the world. Pickens (2011) suggests that when a person is confronted with a stimulus or a situation, s/he interprets it into something meaningful based on prior experiences. What that person perceives may be substantially different from reality.

It is important to understand students' perceptions and attitudes because these form the basis for feeling and action in the learning environment. Perceptions influence behavior and behavior influences decision making – a critical skill for students and classroom instructors. By understanding students' attitudes toward Facebook and how they perceive this form of social media, instructors can design instructional objectives, content, and assessments to enhance learning.

Few studies have researched the potential of web-based technologies to engage students in higher education (Hurt, Moss, Bradley, et al, 2012). Previous research has suggested that investigators should examine how the features of Facebook help build classroom community. An analysis of students' attitudes toward the classroom use of Facebook could serve as the building block. On that foundation research questions could be designed to determine whether Facebook is (1) perceived as a convenient medium for interaction, (2) a contributor to course quality, (3) a mechanism to foster professional growth, and (4) a facilitator of classroom participation.

A recent study of the attitudes of 107 students toward Facebook provides some insights. In a survey designed to compare the attitudes and perceived learning between Facebook and eLearning Commons (a Blackboard Learning Management System tool), Hurt, Moss, Bradley, et al (2012) found that:

1. Facebook was preferred over eLearning Commons as a classroom supplement. Many of the students were already familiar with Facebook, used it frequently and found it easy to navigate.
2. Facebook users became more acquainted with their classmates.
3. Facebook users felt like valued participants and learned more course material.
4. If used appropriately, Facebook may help to increase student engagement by cultivating classroom community and stimulating intellectual discourse.

In sum, Facebook can be used effectively for academic discussions.

Ractham, Kaewkitipong and Firpo (2012) used Facebook as a learning tool in an introductory management information systems course to build and foster an enhanced learning environment. They used the social interactions among Facebook-connected students to develop a constructivist learning atmosphere. A variety of pedagogic strategies were used to integrate activities both inside and outside of the classroom to achieve social learning. The authors sought to implement and evaluate several features of a social networking technology, i.e. Facebook, in an attempt to enhance communication, collaboration, and other innovative uses in future classes. The four features they activated were (1) Social playground through Facebook Wall, (2) Social discussion through Facebook Discussion, (3) Social roll call through Facebook Photos, and (4) Social tube through Facebook Videos.

Seventy five students participated in the Ractham, Kaewkitipong and Firpo (2012) study, which resulted in 55 completed, usable questionnaires. It was found that 55% of the students felt that Facebook helped them in learning. Even more, 78% felt that Facebook was a useful supplemental learning tool. The high volume of communication between students and the positive responses to the survey led to the conclusion that there was great potential for informal learning environments with Facebook as the primary space to communicate and collaborate. The authors observed that some students participated in a casual manner in the same way they would casually interact with friends on their personal Facebook accounts.

Among the lessons learned by Ractham, Kaewkitipong and Firpo (2012) were that Facebook usage in the classroom is time consuming for instructors, yet it is important to communicate frequently with students in order to maintain a high level of interest and activity in the overall learning environment. They also learned that the Facebook effect was somewhat dependent on the instructor's skills, personal characteristics and willingness to commit the time needed. Faculty need to provide structure in spite of more focus on learner centeredness.

de Villiers (2010) studied the potential of Facebook group and discussion facilities for focused academic use. In a study of 35 postgraduate distance-learning students who joined an optional Facebook group to discuss academic content, it was found that learning and perceptions were enhanced by participating in the discussions. The students benefitted from contact with fellow online students; they especially benefitted by researching beyond the assigned study materials and by making personal contributions.

Based on these studies indicating that students had favorable attitudes toward social media-enhanced courses, we advance the first research question:

Is there a difference in the attitudes of students in Facebook-enhanced courses and those in non-enhanced courses on whether Facebook (1) is convenient to use in the classroom, (2) enhances the quality of courses, (3) fosters professional growth, and (4) increases classroom participation?

Community of Practice

This study focuses on learning as a social construct, explained in part by students' sense of classroom community and their establishment of a course level CoP. The social nature of learning can be distinguished from other perspectives that are either cognitive or affective in nature. Lave and Wenger (1991) contend that learning involves engagement in social interaction. It is part of a broader conceptual concept, namely CoP, which constitutes the lowest meaningful context for learning to occur. It is primarily a framework for social participation, in which people are engaged at home, work, school, or other group settings. Typically, individuals are involved in a number of CoPs, which share a common assumption. The assumption is that "engagement in social practice is the fundamental principle by which we learn and so become who we are" (Wenger, 1998, p. 45). The current study is modeled after that of Hung and Yuen (2010), which principally examined students' CoP and sense of classroom community (Rovai 2001, 2002a, 2002b, 2003).

A classroom community is psychological in nature and has the following characteristics: (a) its environment exists in the world of education; (b) its fundamental purpose is learning; and (c) the community has a fixed organizational tenure, i.e., the course or program in which members are engaged has a fixed length (Rovai, 2001). This view of classroom community suggests that any course in which students are enrolled, whether good or bad, can be a classroom community. It implies that any efforts that classmates put into establishing and sustaining their community can be grounded in the framework of classroom CoP (Rovai, 2001).

Research has established the importance of classroom CoPs to facilitate effective learning. Summers and Svinicki (2007) investigated the relationship between students' perceptions of motivation and classroom community. They found that students in cooperative learning classrooms had a greater motivation to achieve goals and a higher sense of community than those in non-cooperative learning classrooms. As such, CoP affected students' sense of classroom community. Other studies revealed that teaching, cognitive, and social factors are related to the nurturing of students' sense of classroom community (Garrison, Anderson, & Archer, 2000; Shea, 2006; Shea & Bidjerano, 2008). As cited in Hung and Yuen (2010), Rovai argues that when learners "feel a sense of community, it is possible that this emotional connectedness may provide the support needed for them not only to complete successfully a class or a program, but also to learn more" (2002b, p. 321).

Based on these studies, we advance the second research question:

Is there a difference in the perceptions of the CoP that evolves in Facebook-enhanced courses as compared to the CoP that evolves in non-Facebook-enhanced courses?

Sense of Classroom Community

Classroom community has been described as the sense of trust and interaction between groups of learners (Graff, 2003). It has been suggested that sense of community is imperative to successful learning. It is a type of mutual interdependence among members of a learning community, which has shared goals and values. While classroom community is a shared phenomenon, it is conceivable that individuals differ on the extent to which they sense this trust and interaction. As such, sense of community may be more crucial to some learners than to others. Rovai (2001), for example, noted that females report a greater sense of classroom community than their male counterparts (Graff, 2003).

According to Rovai (2002b), a *classroom community* is a "feeling that members have of belonging, a feeling that members matter to one another and to the group, that they have duties and obligations to each other and to the school, and that they possess shared expectations that members educational needs will be met through their commitment to shared learning goals" (p. 322). Rovai (2002b) contends that classroom community consists of two factors. The first is learning, which is "the feeling that knowledge and meaning are actively constructed within the community, that the community enhances the acquisition of knowledge and understanding, and that the learning needs of its members are being satisfied" (p. 322). The second is connectedness, which is "the feeling of belonging and acceptance and the creation of bonding relationships" (p. 322). A strong classroom community demonstrates characteristics such as shared common interests, active engagement in two-way communications, as well as trusting and helping other members (Rovai, 2002b).

Social media such as Facebook, Google+ and MySpace are designed to facilitate social interaction and information exchange. A number of researchers believe that social networking is the life blood of CoP. Among those researchers are Mason and Rennie (2007) who incorporated several forms of social media to support a local community's development of a land trust. They found that social media supporting social interaction increased the emotional connectedness of community members, which facilitated the development of the land trust.

Social media, especially Facebook, has the capacity to enhance student engagement and satisfaction. In a study by deVilliers (2010), Facebook groups were used to foster optional discussions in an online course. She found that the voluntary Facebook group members benefited in the course by critically thinking about required material and contributing to the online discussion. In another study by Wang et al (2013), Facebook was used by undergraduate students who made up the experimental group. It was not used by students in the control group. Results indicated that the experimental group of Facebook users experienced significantly higher engagement, higher grades and greater satisfaction with their university learning experience compared to the control group.

Schroeder and Greenbowe (2009) conducted a study of undergraduate students in a basic organic chemistry laboratory who participated in an optional, out-of-class Facebook discussion group. Students who participated in the Facebook discussion group posted items more frequently and dynamically than those in the official course website.

Barbour and Plough (2009) analyzed the pedagogical use of social media in an online program at a charter high school. The high school attempted to increase students' SCC by incorporating technologies such as Facebook and Ning. Incorporating social media into the blended learning courses enhanced students' learning experiences, and was found to be effective and well-regarded by both faculty and students. This body of research suggests that social media enhance the learning experience and student engagement in various types of CoPs – professional, informal, and online.

Based on these studies, we advance the third research question:

Is there a difference in the sense of community related to learning and connectedness that students experience in Facebook-enhanced courses as compared to those experienced in non-Facebook-enhanced courses?

3. METHODOLOGY

Description of the Classroom CoP Created with Facebook – Experimental Group

Students at two universities in California and Indiana were encouraged to voluntarily participate in the Facebook component of four different business courses offered during two academic terms. The courses were accounting, business law, human resource management, and organizational staffing. While the subject matter in these courses was different, the classroom style and teaching philosophy of the instructors were similar. Both used a participative, student-focused, collaborative approach to teaching.

The instructors agreed on a uniform teaching protocol so that presentation of the courses was consistent and similar. Thus, course design and instructor differences were minimized. Only students registered for the course were allowed to access the Facebook group page. This protected privacy and provided an environment conducive to postings and the general use of Facebook. What follows is a description of how Facebook was integrated into the instructional design of the courses in order to create an enhanced CoP. All courses used Blackboard as the official course management system and Facebook was employed as an instructional supplement and the experimental intervention.

Students were assigned a term project in their respective courses and worked in teams, usually comprised of four members. The project was required but incorporating Facebook use into the project was optional. Teams using Facebook held virtual meetings, posted YouTube links and research findings relevant to the team project and commented on one another's works. Initially some students were quite unfamiliar with social media technology, but the CoP evolved as they became more comfortable with using Facebook. Some students needed reassurance that their postings were private and would only be viewed by members of the class, i.e., participants in the CoP. They also needed reassurance about the security of the information posted, because while they had no objections to sharing thoughts and opinions in a classroom CoP, they did not want those ideas revealed to employers, outsiders, or even Facebook "friends."

It appeared that Facebook, more so than BlackBoard, facilitated student interactions and had a positive influence on their senses of learning and connectedness. Students in some teams used Facebook for other course work even beyond their assigned projects.

After about six weeks, the semblance of an enhanced CoP became apparent when students started asking questions on Facebook about the upcoming examination, quizzes, holiday break, and deadlines for the submission of their term project. Fellow students who knew the answers to many questions felt comfortable posting a response, which created open dialogue. This was advantageous because sometimes students posted a response before the question was seen by the professor. For example, there was one situation where the professor posted an announcement on Blackboard, but because of a system failure, a majority of the students in the course were unable to see it. One student who saw the Blackboard announcement posted it to the group Facebook page and the information was effectively disseminated immediately to all the students in the course.

The CoP continued to evolve as both students and instructors became increasingly comfortable posting YouTube videos, comments about course-related events on campus, and summaries of material related to the term project. Class participation grew in terms of volume and quality. A review of the times during which material was posted indicated that students' interactions and engagement went beyond their classrooms and scheduled class meeting times.

Students in the control group were not given the opportunity to use Facebook in their courses, which was the experimental intervention. All other aspects of their courses mirrored those in the experimental group.

Students who participated in the Facebook and non-Facebook-enhanced courses were encouraged to complete a paper-based questionnaire, which was designed to assess their course experiences.

Survey Instrument

The questionnaire consisted of 52 closed and open-ended items. To assess students' attitudes toward the use of Facebook in the classroom, eight questions were constructed. Among other things, they related to whether Facebook (1) was convenient to use in a course, (2) enhanced the quality of a course, (3) facilitated professional growth, and (4) increased students' classroom participation. Students responded to these questions as five-point Likert-type items where 1 represented strong disagreement and 5 represented strong agreement.

To assess students' perceptions of the CoP that evolved in the experimental and control groups, a question containing eight sub-items was adapted from the Hung and Yuen (2010) study. The question assessed the extent to which the CoP facilitated (1) knowledge sharing, (2) collaboration and interaction, and (3) learner centered activities. Students responded to these questions as five-point Likert-type items where 1 represented strong disagreement and 5 represented strong agreement.

To assess SCC, a series of questions from Rovai's (2002a) Classroom Community Scale was adopted. Ten questions that have been validated in other studies (Hung and Yuen, 2010; Black, Dawson, & Priem, 2008; Rovai, 2002a, 2003) were used to measure students' feelings of learning-oriented behaviors and their feelings of connectedness. Students responded to these questions as five-point Likert-type items where 1 represented strong disagreement and 5 represented strong agreement. Four questions were reverse scored. Analysis of the questionnaire was carried out such that higher scores on the 10 SCC questions reflected stronger senses of learning and connectedness. The questionnaire for the control group was modified to preserve the essential content of each question, but to reflect the fact that students in the courses of that group did not participate in the Facebook intervention.

The questionnaire, which also assessed student demographics, was administered in a paper-and-pencil format.

Respondents

Respondents included 586 students from 22 face-to-face business courses at two public universities located in California and Indiana, USA. There were a total of 671 registrants in the courses taught by the authors of this paper. Students in those courses voluntarily participated in the survey, which was approved by the universities' Institutional Review Board. The respondents completed the questionnaire anonymously.

Procedure

The study was conducted using a survey methodology in an independent measures static group comparison research design (Campbell & Stanley, 1963). "This is a design in which a group which has experienced X is compared with one which has not, for the purpose of establishing the effect of X" (Campbell & Stanley, 1963, p. 12). The incorporation of Facebook into the instructional design of the respective courses served as the experimental manipulation. There were two groups of courses, with the experimental group receiving the Facebook intervention. The courses in the control group had identical content but did not have the Facebook intervention. During the last week of classes, students in both groups were surveyed. Each student received a paper questionnaire and was informed that completion of the survey was voluntary and would not affect her/his course grade. Each student was also informed that all data collected would be maintained anonymously. Students completed the questionnaire in about 12 minutes.

4. FINDINGS

Characteristics of Respondents

There were 586 respondents to the survey, of which 303 had participated in Facebook-enhanced business courses and 283 had participated in non-Facebook-enhanced business courses. The study consisted of 297 (50.7%) males and 288 (49.1%) females. One respondent failed to indicate gender. The data on age were categorized into two groups: 25 years old or less and more than 25 years old. Three hundred seventy six respondents (64.1%) were between the ages of 18 and 25, while 207 respondents (35.4%) were over the age of 25. Three respondents failed to indicate their age. The majority of respondents (n = 480) had previous experience with online education (81.9%). Similarly, a majority (n = 508) were full-time students (86.7%). In terms of class level, the majority of respondents (88.2%) were upper division students and 11.8% were lower division undergraduate students.

It was found that student-respondents in the experimental group used Facebook once a day or more (62%) and accessed their group page once daily or more (56%). Sixty four percent of the students agreed or strongly agreed with the statement that using Facebook for classroom discussion was very convenient, was more effective in the classroom than Blackboard (31%), and their overall experience using Facebook was very positive (52%). Fifty six percent of the students agreed or strongly agreed that Facebook was well integrated into their courses. Seventy three percent of the students agreed or strongly agreed that they acquired personal or professional growth after completing the course with the Facebook CoP.

Analytic Approach

This study summarizes the results associated with three research questions. Each research question focuses on students' attitudes and perceptions toward Facebook. These serve as the dependent variables designed to measure how students perceive Facebook and its effect in the classroom. In all cases, Likert-type items were employed in the survey instrument completed by the student-respondents. Likert scales are widely used in research studies rooted in education, behavioral sciences, healthcare, and marketing. When responding to a Likert scale, respondents typically indicate their level of agreement to statements with five or seven ordered response levels (deWinter & Dodou, 2010). There is ongoing debate about whether Likert data should be analyzed with parametric statistics such as the t-test or nonparametric statistics such as the Mann-Whitney-Wilcoxon (MWW) test. In a simulation study with five-point Likert items, Gregoire and Driver (1987) did not find a preference toward either the t-test or nonparametric tests. However, a reanalysis of the data two years later pointed to flaws in the original study and it was concluded that parametric tests are more powerful (i.e., exhibit a lower Type II error rate) than their nonparametric counterparts (Rasmussen, 1989). It was also found that there were no large differences between the parametric and nonparametric tests with respect to false positives (i.e., a Type I error rate). In light of the deWinter and Dodou (2010) findings that t-tests and MWW generally have similar power, this study analyzes the Likert-type attitudinal data using parametric statistics, namely t-tests.

First Research Question – Attitudes toward Facebook

Table 1 (in appendix) summarizes the data associated with the questionnaire items designed to measure the attitudes of students in Facebook-enhanced (experimental group) and non-enhanced (control group) business courses. The table shows the mean and standard deviation for eight attitudinal questions to which students in the experimental and control groups responded. It also shows the results of the t-tests employed to determine whether there was a statistically significant difference between the means of each attitudinal item for the experimental and control groups. Levene's test of equality of variances was performed on each item and revealed significance levels less than .05. This indicated that the assumption of homogeneity of variance should be rejected. As such, the independent sample t-tests performed in this study assumed unequal variances between the group means for each of the eight attitudinal items.

The data in Table 1 indicate that students in the experimental group, compared to those in the control group, felt significantly more positive toward Facebook. They thought it was convenient for classroom discussions, a way to improve the quality of their course, and an improvement that should be introduced in more courses. They thought it was more effective than Blackboard and preferred using it over Blackboard. Students in the experimental group felt more connected to fellow students using Facebook than those in the control group. However, there was no significant difference between the experimental and control group students on the issues of professional growth and enhancement of participation. Students exposed to Facebook did not perceive that they experienced more personal or professional growth than students in the control group. Similarly, students in the Facebook-enhanced courses did not perceive that they engaged in more class participation than those in the non-Facebook-enhanced courses.

Overall, students' attitudes on the convenience of using Facebook and its ability to add quality to their courses were positive and significantly greater for the experimental group, as compared to the control group, whose students did not participate in Facebook-enhanced courses.

Second Research Question-CoP Perceptions

Table 2 (in appendix) summarizes the data associated with the questionnaire items designed to measure students' perceptions of the CoP associated with Facebook and non-Facebook-enhanced business courses. The table shows the means, standard deviations, and percentages associated with the experimental and control groups. It also shows the results of the t-tests that helped to determine whether there was a statistically significant difference between the means for each CoP item in the experimental and the control groups. Levene's test of equality of variances was performed to determine whether the significance levels were greater than .05. Since the significance level of Levene's test was less than .05, independent sample t-tests were performed assuming unequal variances between the means for each CoP item.

The data indicate that a greater percentage of respondents in the experimental group agreed or strongly agreed with the statements concerning their CoP as compared to the respondents in the control group. This indicates that the perceptions of students in the experimental group were more positive toward their CoP compared to their counterparts in the control group. The data reveal that there were significant differences between the means of the experimental and control groups for two of the eight items assessing CoP. Those two items related to Facebook's ability to foster collaboration and interaction. On the item related to Facebook's capacity to encourage students to hold forums on topics of interest, there was a statistically significant difference (t = 4.23, df = 503, $p < .001$) between the mean for the experimental group (M = 3.78) and the control group (M = 3.43). On the item related to Facebook's ability to facilitate communication with classmates, there was a statistically significant difference (t = 2.50, df = 523, $p < .05$) between the mean for the experimental group (M = 3.97) and the control group (M = 3.78). Generally, students in the experimental group had more positive perceptions of their CoP than students in the control group. There were no significant differences between the experimental and control group means for any of the items related to Facebook's ability to promote knowledge sharing or learner-centered activities in the CoP.

Third Research Question – Sense of Classroom Community: Learning and Connectedness

Table 3 (in appendix) summarizes the data associated with the questionnaire items designed to measure students' perceptions of the SCC in their Facebook and non-Facebook-enhanced business courses. The table shows means, standard deviations, and percentages associated with the sense of learning and sense of connectedness items for the experimental and control groups. It also shows the results of the t-tests that helped determine whether there was a statistically significant difference between the means for the SCC items in the experimental and control groups. Levene's test of equality of variances was performed to determine whether the significance levels were greater than .05. If so, an independent sample t-test was performed assuming equal variances between the means for the respective SCC item. If the significance level of Levene's test was less than .05, the independent sample t-test was performed assuming unequal variances between the means for the respective SCC item.

The data indicate that there was a statistically significant difference between the experimental group (M = 19.41) and the control group (M = 20.09) associated with the composite scale for sense of learning (t = 2.27, df = 581, $p < .05$). There was no difference between groups for the composite scale associated with sense of connectedness. What is counterintuitive is the direction of the differences for sense of learning. The students in the control group, who did not participate in the Facebook-enhanced courses, actually experienced a greater sense of learning. While not statistically significant, students in the experimental group (M = 16.46), as contrasted with those in the control group (M = 15.94), experienced a greater sense of connectedness. The students in the experimental group participated in Facebook-enhanced courses.

There was a statistically significant difference between the means for the experimental and control groups for two of the 10 items associated with students' SCC. Students in the experimental group had a significantly lower mean score (M = 3.80) than those in the control group (M = 3.95) on the sense of learning item that read "I am given ample opportunities to learn" (t = 2.10, df = 577, p < .05). However, students in the experimental group had a significantly higher mean score (M = 3.24) than those in the control group (M = 3.04) on the sense of connectedness item that read "Students in this course care about each other" (t = 2.71, df = 577, p < .01). There were no statistically significant differences between the experimental and control groups for the remaining eight SCC items. These findings provide only minimal support for the hypothesis that Facebook-enhanced courses facilitate students' sense of learning and sense of connectedness.

5. CONCLUSION

Three Research Questions

This article discussed the results of a study designed to establish whether students perceived a difference in their perceptions of social media, CoP, and SCC when Facebook was integrated into the instructional design of their business courses. Facebook, the most globally popular social networking site, served as the classroom intervention in a study using a static group comparison research design. In the experimental group students participated in the Facebook intervention. In the control group students did not participate in the intervention.

Relative to the first research question, there were significant differences between the experimental and control groups on the issue of students' attitudes toward the use of the social media – Facebook – in their courses. Students participating in the Facebook-enhanced courses reported that Facebook was a convenient and quality-oriented supplement to their traditional on-campus courses. This finding is consistent with the work of Hurt, Moss, Bradley, et al (2012). Compared to the control group, students in the Facebook-enhanced (experimental) group thought that Facebook should be introduced in more courses and that it made them feel more connected to their classmates. The results of this study are in accord with Sanchez, Cortijo, and Javed (2014) who found that among undergraduates at the University of Huelva (Spain), students were influenced to adopt Facebook to establish contact with others with whom they shared interests. Students in the experimental group, as compared to the control group, did not perceive that using Facebook in the classroom had a significant impact on their professional growth or ability to participate effectively in their courses. On these two variables, there were no significant differences between the means for the two groups.

In the second research question, we examined whether students perceived the CoP that evolved in their Facebook-enhanced courses was different from the CoP in the non-enhanced courses. Statistically significant differences were found between the experimental and control groups for two of the eight variables measured. The experimental group, as compared to the control group, had significantly higher mean scores for two of the three items related to collaboration and interaction. This indicates that incorporating Facebook into the instructional design of a course affects students' perceptions of social learning, i.e., the CoP that evolves in a classroom environment. An overwhelming majority of students in the experimental group perceived that Facebook allowed students to create forums to discuss topics of interest (69%) and to communicate with classmates (78%). Clearly, Facebook facilitated engagement among students in course-related dialogue, which is believed to have impacted their overall learning experience. Consistent with research by Garrison, Anderson, and Archer (2000), Shea (2006), and Shea and Bidjerano (2008), the integration of Facebook into students' courses was a social factor that created an effective CoP.

Overall, students in this study perceived some benefit from adding Facebook to their courses. They thought that it improved the quality of their courses, was more effective than Blackboard, and enabled them to feel more connected to their classmates. Facebook contributed to the enhancement of the CoP in business courses because of its capacity to facilitate collaboration and interaction. However, the use of Facebook in the classroom was not found to significantly improve students' CoP in terms of knowledge sharing and learner-centered activities. The Facebook effect in university classrooms, therefore, is considered moderately positive.

In the third research question, we examined whether students perceived the SCC in their Facebook-enhanced courses to be different from the SCC in non-enhanced courses. Statistically significant differences between the experimental and control groups were found for two of the ten SCC variables. In terms of students' sense of learning, there was a significant difference between the mean scores for the experimental and control groups on the composite scale. Students in the control group perceived a greater sense of learning than those in the experimental group. In other words, students perceived a greater sense of learning in their non-Facebook enhanced courses. This finding is contrary to the results of earlier studies, which were based on analyses of data from non-control group designs (Barczyk & Duncan, 2013) or on the analysis of a single activity such as posts to a discussion group (Schroeder & Greenbowe, 2009). It was initially believed that Facebook-enhanced courses resulted in students having an increased sense of learning. The data from this study shows just the opposite.

Overall, students in this study perceived no benefit from adding Facebook to their courses in terms of their sense of connectedness. There was no difference between the mean score of students in the experimental group and the control group on the composite scale for sense of connectedness. Only one item indicated that students in Facebook-enhanced courses felt that their classmates cared about each other. There was a statistically significant difference between the means of the experimental and control groups for this item, which revealed that Facebook had a positive effect on students' sense of connectedness in terms of their caring more about each other when Facebook was incorporated into the instruction design of their course. The results associated with this single item are consistent with those of Junco, Heiberger, and Loken (2011) who found that when Facebook was used in the classroom students felt more engaged. Engagement occurs when students care about each other.

Implications for Teaching

A major finding of this study is that Facebook facilitated the development of an enhanced classroom CoP. This has implications for teaching and learning. According to Junco (2012), students who have strong feelings of community because of enhanced collaboration and interaction are more likely to be engaged and persist in their studies (Rovai, 2002b) than students who feel alienated or alone. Instructional design strategies that help establish and maintain the CoP in courses may help student learning, engagement, and possibly retention.

By facilitating interaction and collaboration, Facebook may provide students with the opportunity to engage beyond their classroom periods. Students were noted to post items in their Facebook-enhanced CoP outside of their designated class meeting times. It is believed that this increased participation in course-related discussion and created a positive learning experience. Instructors should examine and consider using Facebook so as to create a productive learning community. They should note, however, that supplementing a course with Facebook is time-intensive. As VanDoorn and Eklund (2013) point out, if social media are to be properly incorporated into teaching, instructors need to be fully aware of the time resources required to provide this level of learning support. Furthermore, students may find that they are overloaded with the abundant information shared by members of their CoP. As such, instructors should develop a strategic instructional plan and a structured mechanism for information sharing and interaction to manage their classroom CoP. In so doing, they can insure its effectiveness and benefits.

When using Facebook for instructional purposes in higher education, instructors should respect students' need for privacy and information security. As students are introduced to Facebook in their courses, a concerted attempt should be made to limit outsider access to group pages. Only members of the CoP, i.e., students officially registered for the course, should be allowed to access the group Facebook page.

Until the instructional efficacy of social media is better documented, faculty should use prudence in enhancing their courses with Facebook.

Limitations

This study has two potential limitations. The first relates to its use of a single survey instrument, which could result in a common method bias. Future research should use additional methods for collecting data such as interviewing or focus groups. This would buttress survey results and lessen the threat to validity occasionally observed in educational research that uses a single data collection instrument (Donaldson & Grant-Vallone, 2002). The second limitation relates to this study's reliance on self-report measures. Even though the student respondents completed the questionnaire anonymously, there is the potential for social-desirability bias.

Future Research

Using an experimental research design, this study documented the effect of social media on students' perceptions of their classroom CoP and senses of learning and connectedness. These findings are based on self-reported subjective measures. Future research should be designed to go beyond measures of attitudes and perceptions. Studies should measure the extent to which Facebook and other social media impact actual learning outcomes and student performance. These objective measures would provide additional insights into the pedagogical value of social media.

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Editor's Note:

This paper was selected for inclusion in the journal as a EDSIGCon 2015 Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2015.

Appendix

Questions [a]	Experimental [b] *M* (*SD*)	Control [b] *M* (*SD*)	*df*	*t*
Facebook for classroom discussions is very convenient	3.57 (0.99)	2.93 (1.18)	549	7.07***
Facebook improved the quality of my course	3.17 (0.97)	2.72 (1.08)	565	5.30***
Facebook should be introduced in more courses	3.30 (0.93)	2.79 (1.17)	536	5.82***
Facebook was more effective than Blackboard	2.86 (1.13)	2.53 (1.19)	578	3.46***
I preferred using Facebook over Blackboard	2.94 (1.15)	2.51 (1.25)	566	4.39***
I felt more connected to fellow students using Facebook	3.39 (0.99)	3.01 (1.28)	528	4.02***
I acquired personal or professional growth using Facebook	3.81 (0.82)	3.90 (0.85)	579	1.33
Facebook enhanced my experience of participation in this course	3.81 (0.76)	3.76 (0.83)	565	0.73

Notes:
[a] Rated using five-point Likert-type items where 1 = strongly disagree, 5 = strongly agree
[b] $N = 303$ for the experimental group; $N = 283$ for the control group
*** $p < .001$

Table 1

Students' ratings on questions assessing their perceptions of Facebook usage

Item [a]	Experimental [b] *M*	*P* [c]	Control [b] *M*	*P* [c]	*df*	*t*
Knowledge Sharing						
Social networking site allows me to share my personal interests	3.43 (0.90)	53	3.58 (1.08)	53	533	1.80
Social networking site allows me to find and share educational resources	3.75 (0.85)	67	3.63 (1.04)	53	523	1.41
Social networking site promotes knowledge sharing	3.87 (0.82)	73	3.80 (1.01)	64	524	0.88
Collaboration and Interaction						
Social networking site allows me to hold forums to discuss topics of interest	3.78 (0.82)	69	3.43 (1.08)	46	503	4.23***
Social networking site allows me to communicate with classmates	3.97 (0.79)	78	3.78 (0.98)	67	523	2.50*

Social networking site provides collaborative learning opportunities	3.81 (0.87)	68	3.68 (1.03)	57	531	1.63
Learner-Centered Activities						
Social networking site allows me to personalize pages to express individuality	3.42 (0.91)	50	3.49 (1.03)	48	541	0.87
Social networking site encourages learner-centered activities	3.59 (0.81)	55	3.50 (1.04)	50	515	1.11

Notes:
[a] Rated using five-point Likert-type items where 1 = strongly disagree, 5 = strongly agree
[b] N = 303 for the experimental group; N = 283 for the control group
[c] Indicates the percentage of respondents who agreed or strongly agreed with this item
[***] $p < .001$
[*] $p < .05$

Table 2

Students' ratings on items assessing the perceptions of their CoP

Questions [a]	Experimental [b]		Control [b]			
	M	*P* [c]	*M*	*P* [c]	*df*	*t*
Sense of Learning						
Composite Scale	*19.41 (3.50)*		*20.09 (3.74)*		*581*	*2.27*[*]
I am encouraged to ask questions	3.78 (0.93)	66	3.88 (0.94)	71	574	1.32
Is not hard to get help when I have a question [d]	3.98 (0.87)	78	4.12 (0.93)	79	572	1.88
My educational needs are being met [d]	3.95 (0.92)	74	4.09 (0.99)	74	570	1.84
I am given ample opportunities to learn	3.80 (0.82)	71	3.95 (0.90)	76	577	2.10[*]
Course promotes a design to learn [d]	4.01 (0.91)	75	4.13 (1.00)	76	566	1.52
Sense of Connectedness						
Composite Scale	*16.46 (3.26)*		*15.94 (3.89)*		*552*	*1.72*
Students in this course care about each other	3.24 (0.87)	37	3.04 (0.95)	28	577	2.71[**]
This course is like a family	2.76 (1.01)	31	2.61 (1.05)	18	576	1.71
I do not feel isolated in this course [d]	3.88 (0.91)	68	3.93 (1.02)	69	579	0.63
I can rely on others in this course	3.14 (1.01)	39	3.12 (1.07)	39	577	0.26
Others will support me	3.49 (0.87)	52	3.39 (0.92)	44	578	1.44

Notes:
[a] Rated using five-point Likert-type items where 1 = strongly disagree, 5 = strongly agree
[b] N = 303 for the experimental group and N = 283 for the control group
[c] Indicates the percentage of respondents who agreed or strongly agreed with this item
[d] Reverse scored question, framed positively in this table
[**] $p < .01$
[*] $p < .05$

Table 3

Students' Ratings on Questions Assessing Their Sense of Classroom Community

How secure is education in Information Technology? A method for evaluating security education in IT

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Abstract

As the popularity of Information Technology programs has expanded at many universities, there are a number of questions to be answered from a curriculum standpoint. As many of these programs are either interdisciplinary, or at least exist outside of the usual Computer Science and Information Systems programs, questions of what is appropriate for the curriculum and accreditation have arisen. More specifically, as the demand for information security professionals has expanded enormously, IT majors will increasingly be asked to fill these roles. This paper seeks to examine the curriculum for IT programs with a special focus on security. Security has become an increasingly important topic, and one that IT graduates will likely be dealing with professionally. We answer this question by examining the curriculum guidelines for IT programs, and comparing these to both professional standards and IT program curriculums at several universities.

Keywords: IT Education; Curriculum; Accreditation; Security; Certification.

1. INTRODUCTION

The Need for Information Security

The demand for Information Security professionals is at an all-time high, yet there is no readily available research outlining specific education deliverables within an Information Technology curricula to prepare students. A study found that the demand for cybersecurity professionals over the past five years grew 3.5 times faster than for other IT jobs (Vijayan, 2013). The Bureau of Labor and Statistics predict information security analyst jobs to grow 22% from 2010 to 2020 (U.S. Department of Labor, 2013). Not only is the demand increasing but salaries for security professionals are typically higher than others in IT. Robert Half Technology's 2015 Salary Survey shows a network security administrator can expect to earn between $99,250 and $138,500 and a data security analyst can expect to earn between $106,250 and $149,000 annually (Robert Half Technology, 2015).

In May 2009, President Barack Obama identified cybersecurity as "one of the most serious economic and national security challenges we face as a nation" (Obama, 2009). Since then many schools and universities have begun to offer varying degree programs that focus on Information Security; however, the education delivered at each is quite different. Unlike a math or accounting degree, where there is an acceptable standard by which to measure one school to another, there is no set standard for information security.

Since starting this research in 2013, multiple groups have met to discuss the learning outcomes for Cyber-related educational offerings. One provider of curricula recommendations is the Association for Computing Machinery (ACM). ACM regularly publishes curricula recommendations for Computer Science and Information Technology programs. As of this writing, the most recent Information Technology curriculum guideline for undergraduate programs was published in November 2008 (Association for Computing Machinery, 2015).

Other groups such as the Cyber Education Project (CEP) have formed to develop curriculum guidelines for a "Cyber Science" degree track (Cyber Education Project, 2015). What these groups have in common is the desire to create curricula that meets accreditation standards. However, curricula at various universities need to be explored to understand if these programs are meeting the guidelines outlined for successful security programs.

Our study is designed to evaluate IT programs to understand if these are meeting the needs of the security field. The following questions are evaluated in the subsequent sections:

- Are curricula at various universities covering the guidelines set out for security education?
- Furthermore, do these guidelines meet the needs of employers based on their measures of qualifications (e.g., certifications)?

2. LITERATURE REVIEW

It is clear that education is key to obtaining a job as a security professional. The 2013 IT Salary Survey on Security performed by InformationWeek shows that 99% of participants indicated they had completed at least some higher education or tech school classes, as shown in **figure 1** (All of the tables and figures for this study are presented in **Appendix 1**) (Lemos, 2013). According to the Bureau of Labor and Statistics, "Information security analysts usually need at least a bachelor's degree in computer science, programming, or a related field" (U.S. Department of Labor, 2013). This is supported by a survey of 682 IT Security professionals (Lemos, 2013). Of those who responded, between 77% and 78% of respondents had a Bachelor's degree or higher (see Figure 1). Additionally, higher education can also serve as a substitute for experience, as some job postings mention that education can be utilized in lieu of experience. In the subsequent sections, security in education will be discussed and expanded on. This is followed by expanding the discussion of education into the area of certifications.

Security in Education

To address the need for some common understanding about cybersecurity, the National Institute of Standards and Technology (NIST) was tasked with creating a cybersecurity framework. The result was the National Initiative for Cybersecurity Education (NICE). "The goal of NICE is to establish an operational, sustainable and continually improving cybersecurity education program for the nation to use sound cyber practices that will enhance the nation's security" (National Institute of Standards and Technology, 2011). The NICE framework was designed to help map course work to a predefined set of knowledge, skills, and abilities (KSAs). The framework addresses what skills are needed for various types of jobs; however, it does not provide specifics on what education and certifications are required to obtain the necessary skills. This framework was used by the ACM as a starting point for the development of curriculum guidelines for universities (McGettrick, 2013). This suggests the ACM guidelines provide a sufficient measure universities can use to understand if their curriculum is meeting the needs of employers seeking cybersecurity professionals. However, this may not be the lone measure to assess curricula.

On November 19th and 20th, 2013, the inaugural Cyber Education Symposium was hosted in Arlington, VA. The event featured representatives from industry, government, and education in a panel format to discuss how to better prepare a cybersecurity workforce. The various panels met to discuss challenges and spoke in very abstract terms about educational requirements. The last plenary panel consisted of Robert Hutchinson, Sandia National Labs; Albert Palacios, the Department of Education; Evan Wolff, Crowell & Moring; and Tom Baughan, Monster.com. The entire panel was asked to give their opinions as to what specific education they wanted to see out of two- and four-year graduates. The answers given were still very abstract. At the conclusion, a few members suggested that certifications are currently how many representatives from the various industries assess the security education of potential employees. This is similar to how the Department of Defense and other government agencies currently handle education in which they have specific requirements for Information Assurance workers including both training and certifications (for more information, see DoD 8570 for a list of certifications required by federal employees).

Certifications are often used as a bar for employers to understand if job candidates have the knowledge needed for a position in security. Because higher education is meant to develop students ready for the workforce, it would be helpful to understand if the current guidelines set out by ACM and adopted by universities meet the knowledge and skills tested through certification. Thus, in the subsequent section, certifications are discussed and the skills/knowledge gained through these certifications are compared to the current IT curriculum guidelines.

The Value of Certification

Certifications offer a standardized way in which employers can assess future employees. From the previously referenced survey of IT professionals, the following question was posed to understand the value of education/training (e.g., certifications) for security professionals: "What type of training would you find most valuable to you in developing your career?" (Lemos, 2013). The answers given to this question provides an honest assessment of where the participants feel they need to improve (see **Figure 2**). Note that certification courses rate as one of the top two considered most valuable in further developing a security career, only slightly behind the need for technology-specific training. A recent study of government workers found that "staff members holding certifications make $12,000 more and managers make $10,000 more in base salary than their noncertified counterparts" (Ballenstedt, 2013).

According to the 2013 and 2014 US IT Salary Surveys of IT security staff and management professionals performed by InformationWeek, more than 60% of those surveyed have at least one security certification. The same surveys also provided statistics about the effect security certifications have on compensation. Certification attributes to an average increase in total compensation of over $9,000 (Lemos, 2013).

Another survey found that "a $21,000 boost in salary can be yours if you obtain Certified Information Systems Security Professional (CISSP) or two other major security certifications" (Brodkin, 2008). The article cited research by Foote Partners, an IT research and advisory firm that monitors compensation of IT professionals.

The review of both guidelines and certification suggest there are a variety of approaches to security education. Based on this, it is clear there needs to be a set of standards that properly equips a cybersecurity workforce. There is consensus that certain jobs require specific certifications. But are we preparing our students to fill these needs? Do our curriculum guidelines match up with the skills that our employers are demanding? Furthermore, are the guidelines set out by ACM and used by most universities aligning with skills and knowledge tested through certifications?

In the subsequent section, we first evaluate ACM guidelines on IT curricula at various universities. We then expand on these ACM guidelines by comparing them to the most popular certifications in security related fields to understand if these guidelines meet the skills/knowledge set by these certifications.

3. METHODOLOGY

To understand how universities are currently incorporating security into their curriculum, a qualitative study examining current information technology curriculum was performed. Evaluating all programs in Information Technology was beyond the scope of this research. Instead, this research evaluates the Information Technology degree programs within the University of North Carolina education system. This provided a smaller set of universities to help in developing a guideline to evaluate other universities in multiple states.

The evaluation is based on the established curriculum and accreditation guidelines for this area. The University of North Carolina education system (UNC System) consists of "16 university campuses across the state" (University of North Carolina, 2015). To ensure similar programs are evaluated, Classification of Instruction Programs (CIP) codes are utilized. CIP was "developed by the US Department of Education's National Center for Education Statistics in 1980 for the accurate tracking and reporting of fields of study and program completions activity" (US Department of Education: Institute of Education Sciences, 2015). For this research, the Information Technology programs with a CIP code of 11.0103 were evaluated. All the schools within the UNC System are accredited by the Southern Association of College and Schools (SACSCOC, 2014). The schools with an IT degree program are shown in Table 1 (in Appendix).

Once each school with a qualifying program was identified, required core classes and electives were evaluated. The purpose of this research is not to compare a given program to another, but rather focuses on the required core classes that include security, and any security related electives offered. In order to identify classes that include security, the search terms "security", "secure", "crypto", "assurance", "intrusion", and "protect" were used. These terms were selected after a pre-evaluation of the course catalogs of the schools evaluated, and were then verified by four subject matter experts as being an appropriate grouping of words to demonstrate courses falling under the security umbrella. This included two faculty currently teaching in the security curriculum and one industry expert. Each university's course catalog was searched and classes that matched these keywords were added to the analysis.

Utilizing the keywords resulted in a reduced chance of overlooking a course that delivers security related content; however, each catalog was reviewed fully for any additional security class offerings. The results from this are shown in Tables 2 and 3. While evaluating the curriculum at each UNC System school, an effort was made to determine if a certification is currently a deliverable. Of the classes evaluated, there was no mention of any requirement for a certification as a class prerequisite, or requiring certification for class completion.

Guidelines and Certification Comparisons

First, courses were compared to the elements set out by the ACM IT IAS guidelines (Association for Computing Machinery, 2015). These guidelines set out 11 knowledge areas (KAs) that are suggestions of topics to be covered as well as time to be given to each topic. Each knowledge area contains various components of specific topics that will be compared to courses currently being offered in IT curricula.

Next, an analysis of the CISSP, Security+, and CEH certifications was performed, breaking the body of knowledge for each certification into its component parts. These certifications were chosen based on an evaluation of jobs currently available in security, and the certifications most commonly identified as being required/preferred (see Figure 3). This information was collected through a search of the Dice.com employment database for the term "security analyst" limited to include only Georgia, South Carolina, North Carolina, and Virginia. Forty-four of the 60 jobs returned, or 73%, had a Bachelor's degree listed as either preferred or required. Forty-one of the 60 jobs had either a required or suggested minimum experience listed. Of those with a required minimum, 32 of them required five years or less experience.

The search also revealed 60% had some form of certification requirement or recommendation. The most popular certification requested was CISSP, with Security+, Certified Information Systems Auditor (CISA), and Certified Ethical Hacker (CEH), all tied for second. Further evaluation of these four certifications revealed that the CISA certification concentrates on auditing, and has a five year minimum experience requirement, so it was not evaluated as part of this research.

Common elements from each certification were identified, and then evaluated by the subject matter experts to ensure the elements were appropriately classified. Once these were confirmed, the elements were then used to evaluate the classes being taught. The goal is to create a list of required elements of security that should be taught, yet be certification neutral. This is referred to as the recommended body of knowledge. These were then compared to the current knowledge areas that encompass the ACM curricula guidelines to assess if these guidelines cover the recommended body of knowledge from certifications. Lastly, the opposite is compared in which certifications are evaluated against the ACM guidelines to understand if certifications encompass these guidelines. The content of each class was compared to the recommended body of knowledge to see how many elements are being fulfilled. Once each class had been evaluated, each University program was evaluated, based on its fulfillment of the recommended body of knowledge.

4. RESULTS

Are the courses covering the Material?
The first evaluation was made by looking at the curriculum in the UNC IT programs and comparing it to the key elements of the ACM guidelines. Table 2 shows the university, degree program and the courses offered that have a required security element. The courses listed are broken out by whether they are required for IT majors, or are elective courses. The analysis for this study focuses on the required courses, as students may or may not take a given elective.

Table 3 shows the required courses at each school that contain a key security element identified by the ACM. Table 4 shows how these key elements map to the ACM IT guidelines. Table 5 reflects a summary of a detailed evaluation of each required and elective classes offered in Information Technology curriculum programs within the UNC System and shows that all the elements of the ACM IT IAS guideline KA's are being taught in required courses. It can also be seen from the data, however, that not every school is covering every element of the curriculum in required classes. This finding is hardly surprising, given that the curricula vary between schools.

Does ACM = Certifications?
The next question this study set out to answer was: Are the ACM Guidelines covering skills required by the popular certifications? In order to measure this, the study compared the detailed elements of the ACM IAS with the three certifications identified as the most popular (CISSP, Security+ and Certified Ethical Hacker). The comparison of the certifications is shown in table 6. This table maps the elements of each certification to those identified by the ACM, with references to the section of the certifications guides where that knowledge area can be found. It is interesting to note that none of the certifications covers all of the areas of the ACM guidelines.

The next question is, do the ACM guidelines cover all aspects of the security certifications? In order to answer this question, a similar analysis was preformed, but in reverse. Each certifications knowledge areas were listed and mapped against the ACM guidelines.

CISSP was the most commonly listed certification in job postings, so we begin there. Table 7 shows, in summary, that the ACM guidelines do not cover all of the knowledge areas required by this certification. While all of the areas are covered at least partially, the coverage varies from 25-75%. In particular, CISSP requires more in the area of secure development and what could be viewed as the "managerial" aspects of security, such as risk management and asset security. The fact that the ACM guidelines miss so many of the "managerial" aspects of security is particularly troubling, as these make up the majority of cyber security best practices (Kleinberg, Reinicke and Cummings 2015).

Table 8 shows that the ACM guidelines cover 100% of the knowledge areas required by the Security+ certification. This is perhaps not surprising, as the Security+ certification is a more general certification than the others listed here. However, it also indicates that an IT degree program that follows the ACM guidelines will by default prepare its students for this certification.

The final certification examined in this study is the Certified Ethical Hacker (CEH). The comparison of the CEH to ACM guidelines is presented in table 9. Here the ACM guidelines cover from 0-100% of the knowledge areas listed by the certification. This is an interesting finding, and serves to highlight the fact that the CEH is a very detailed, technical certification. This particular certification goes into great depth on every area of hacking, which is very unusual to find in academic programs, because it is so specific.

Do Certifications = ACM?
The next analysis performed was to measure the percentage of the ACM guidelines covered in the knowledge areas of each of the certifications. A summary of this comparison is found in table 10. Once again, we can see that the overlap with the Security + certification is the highest, at 100% for all of the knowledge areas.

However, while the ACM guidelines do not fully cover the CISSP and CEH certifications, neither do these certifications cover all of the ACM guidelines. The reverse coverage is significantly better for the CISSP, ranging from 64-100%. That is to say, the knowledge areas from the CISSP more fully reflect the ACM guidelines, which shows that the certification covers more areas overall than the ACM guide. Again, this is not a surprise as the CISSP is a specialized

certification that would go into more depth than a general IT program would be expected to.
Finally, the CEH covers between 0 and 100% of the ACM knowledge areas. Once again, this is not surprising as the CEH is a very in depth technical certification, which is not designed to cover all aspects of IT education.

Recommendations

Based on the comparison of the ACM IT guidelines and the requirements of the three certifications examined, it is clear that there is a great deal of overlap. In practical terms, this means that those programs following the ACM recommendations for their IT programs are covering the majority of what the students would see on some of the more general security certification exams.

This same analysis, though, points out that more attention needs to be paid to the managerial aspects of security. While it is possible that some of these items are covered in courses that were not specifically security classes, and did not appear on our analysis, it seems likely that more attention needs to be paid to this area.

Finally, this analysis shows an academic program will be hard pressed to prepare its students for a more technical certification exam, like the CEH. These certifications are very technical and specific in nature. It could be argued that it is inappropriate for a general degree program to prepare students for something like this. It could, however, be possible for a program to create a specialized track that would prepare students for the CEH while covering the broader topics required by the ACM in other courses.

Limitations

This study looked only at schools within the UNC system. In addition, not all of the IT programs were considered. Only those coded the same in the system were compared for consistencies sake. The study did not have access to the syllabi for all of the courses listed in each of these programs, so the assessment was based upon the catalog descriptions. As technology classes tend to evolve more quickly than university catalogs, it is possible that the courses cover topics other than those listed in the descriptions.

This study also did not look at elective courses within the programs. While there may be additional security topics covered in elective courses, there is no way to ensure that all students take a particular elective. As the purpose of the study was to see how the base curriculum compared with the requirements in security, only those courses were examined.

Another limitation included only examining the ACM curriculum guidelines along with a limited number of certifications. We chose these guidelines as they provide a general overview of Information Technology curriculum that many universities are trying to incorporate into their curriculum. There are a number of additional resources (e.g. Cyber Education Project) that can be used for future examination.

Finally, this study looked only at the University of North Carolina system. As such, it is difficult to draw conclusions nationally with this study. However, the study does provide a method for evaluation of programs in other states.

Future Work

This study could be expanded to other states to examine IT education in those areas of the country. This could also be expanded to include the elective courses offered within a program to see if a student could fulfill all of the requirements for the security certifications by taking additional coursework. Finally, it may be beneficial to examine all course in IT programs to make suggestions as to where security to be included to help prepare students for the security field.

5. CONCLUSIONS

This research does not attempt to settle the debate of whether certifications should or should not be a deliverable in an educational setting. However, it is clear that a properly delivered security minded curricula does provide a solid foundation for at least two of the top three certifications identified in this research, namely Security+ and CISSP.

The research also demonstrates that there is a wide variation in the amount of time spent on security education in different schools. This is certainly understandable, but points to a problem moving forward. As security becomes more critical in an ever more connected society, educating technology professionals on security becomes crucial. This is far from an insurmountable problem – it simply requires a reexamination of course material to include security where applicable.

The ACM IT Curricula Guidelines used in this research are just that, guidelines. It was not intended to be a mandatory implementation list. This research has shown that there is a demand for individuals who are experts in security. This shows that there are synergies for those programs that more closely follow the guidelines. An effective implementation of these guidelines will fulfill both the educational mission of the university and provide the skills required by employers.

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Appendix 1: Tables and Figures

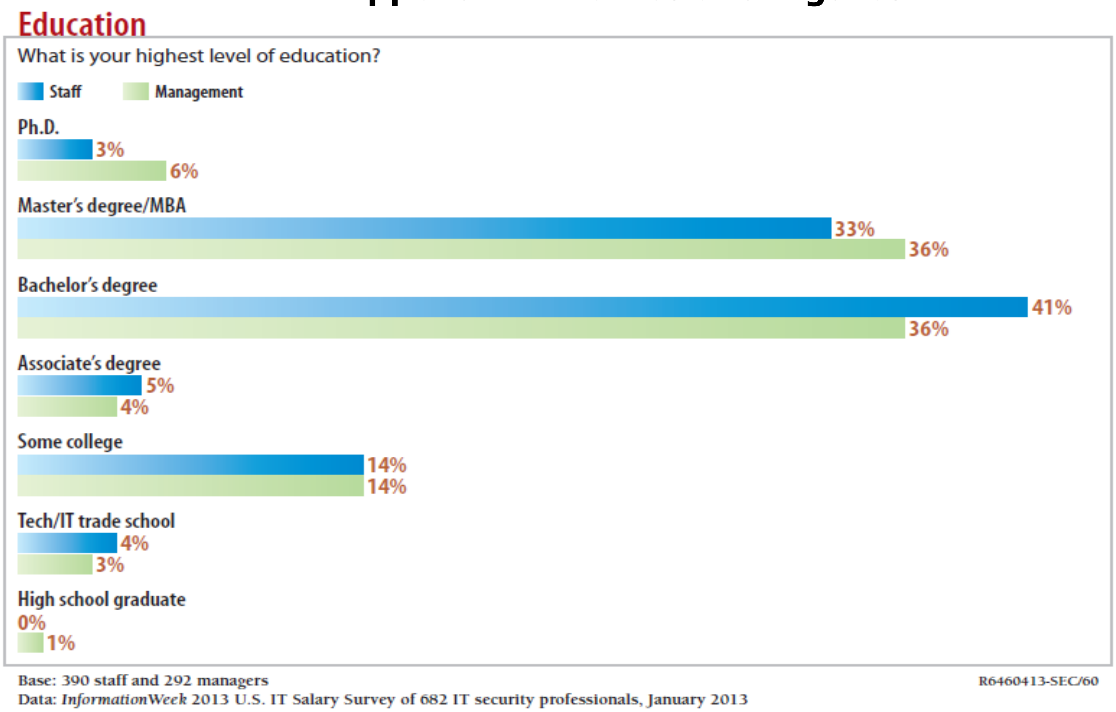

Figure 1 – Education level held by participants (Information Week 2013 Salary Survey)

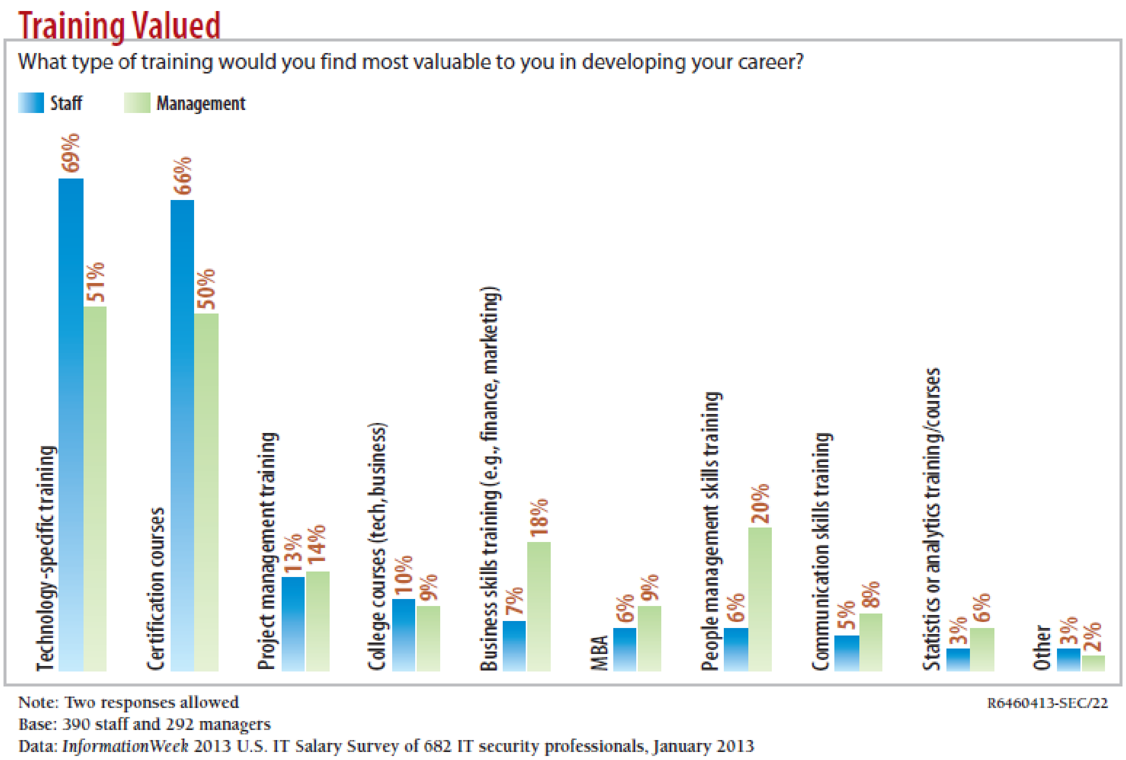

Figure 2 – Security, Most Valuable Training (InformationWeek 2013 Salary Survey)

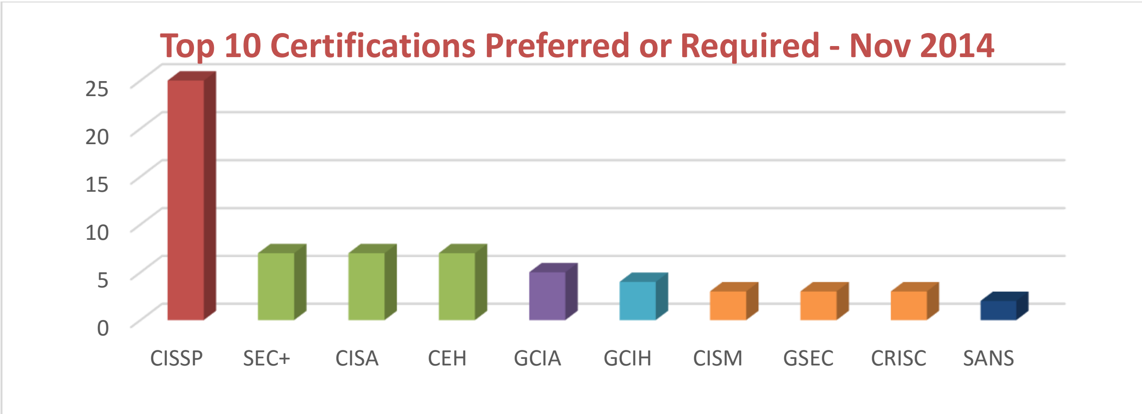

Figure 3 – Certifications preferred of required based on November 2014 Job Listings

	CIP	Information Technology			Accreditation (ABET, 2015)
		BS	MS	PhD	
East Carolina University	11.0103	X			
NC A&T State University	11.0103	BS in Information Technology program starting Fall 2015[1]			
UNC Charlotte	11.0103		X		
UNC Pembroke	11.0103	X			
UNC Wilmington	11.0103	X			
Winston-Salem State University	11.0103	X			ABET: IT,BS 2011-Present

Table 1 – UNC System Schools with an IT degree program

CIP Code	UNC School	Degree	Required Security Classes	Security Electives
11.0103	East Carolina University	BS IT	ICTN 4200, 4201, 4800, 4801	
11.0103	UNC Charlotte	MS IT	ITIS 6200	ITIS 5220, 5221, 5250, 6150, 6167, 6210, 6220, 6230, 6240, 6362, 6420
11.0103	UNC Pembroke	BS IT	ITC 2080	ITC 3250
11.0103	UNC Wilmington	BS IT	CIT 204, 324, 410, 213	
11.0103	Winston-Salem State University	BS IT	CSC 3325	

Table 2 – Information Technology classes with a security component

Key Security Element	Distribution		
Database	CIT 213 (UNCW)		
Information, Privacy & Security	ITIS 6200 (Charlotte)	CSC 3325 (Winston)	
Intrusion Detection	ICTN 4200 (ECU)	ICTN 4201 (ECU)	
Information Assurance	ICTN 4800 (ECU)	ICTN 4801 (ECU)	
Systems Administration	ITC 2080 (Pembroke)		
Digital Media	CIT 204 (UNCW)		
Info. Sec. Management	CIT 324 (UNCW)		
Web App. Development	CIT 410 (UNCW)		

Table 3 – Distribution of Information Technology Required Classes with a Security element

Key Security Element Being Taught	Most Closely Maps to ACM IT Guideline
Database	IAS/Security Domains

[1] http://www.ncat.edu/academics/schools-colleges1/sot/index.html, January 30, 2014

Key Security Element Being Taught	Most Closely Maps to ACM IT Guideline
Information, Privacy & Security	IAS/Fundamental Aspects, IAS/Security Mechanisms, IAS/Policy, IAS/Security Domains, IAS/Security Services, IAS/Threat Analysis Model, IAS/Vulnerabilities
Intrusion Detection	IAS/Attacks, IAS/Vulnerabilities
Information Assurance	IAS/Fundamental Aspects, IAS/Security Domains, IAS/Information States, IAS/Security Services
Systems Administration	IAS/Information States
Digital Media	IAS/Security Mechanisms, IAS/Forensics, IAS/Information States
Info. Sec. Management	IAS/Fundamental Aspects, IAS/Operational Issues, IAS/Policy, IAS/Security Domains, IAS/Security Services, IAS/Threat Analysis Model, IAS/Vulnerabilities
Web App. Development	IAS/Attacks, IAS/Vulnerabilities

Table 4 – Information Technology security elements being taught mapped to ACM IT IAS guidelines

UNC School	Degree	KA's Fulfilled (max 11)	% ACM IT IAS Guideline being delivered. (KA's offered / 11 KA's)
East Carolina University	BS	6	55%
UNC Pembroke	BS	5	45%
UNC Wilmington	BS	11	100%
Winston-Salem State University	BS	7	64%
UNC Charlotte	MS	11	100%

Table 5 – Evaluation of Information Technology Degrees with required and elective courses that include security elements compared to ACM IT IAS guide line

ACM IAS Guideline for Information Technology	CISSP	Security+ SY0-401	CEH 312-50
1. IAS/Fundamental Aspects [3 hours]			
1.1 History and terminology	Throughout	Throughout	Throughout
1.2 Security mindset	Throughout	Throughout	Throughout
1.3 Design principles	3.A-E	1.3	1.6
1.4 System/security life-cycle	7.E	4.1	-
1.5 Security implementation mechanisms	3.A-E	2.9	1.2
1.6 Information assurance analysis model	3.B	3.6	1.1
1.7 Disaster recovery	6.C	2.8	-
1.8 Forensics	7.A	2.4	-
2. IAS/Security Mechanisms			

ACM IAS Guideline for Information Technology	CISSP	Security+ SY0-401	CEH 312-50
2.1 Cryptography	2.E / 3.E,I / 4.A	6.1-3	19.1-8
2.2 Authentication	5.A-B, E	5.1-3	1.6 / 5.4
2.3 Redundancy	7.K	2.8	-
2.4 Intrusion detection	7.C,H	3.6 / 4.3	17.1-2
3. IAS/Operational Issues			
3.1 Trends	-	2.6	1.1
3.2 Auditing	6.E	2.3	20.1
3.3 Cost/benefit analysis	1.G	2.8	1.3
3.4 Asset management	7.D	2.7 / 4.2-3	-
3.5 Standards	1.F / 2.E	2.1-2	-
3.6 Enforcement	8.B	2.3 / 2.5	-
3.7 Legal issues	1.D	4.2	-
3.8 Disaster recovery	6.C	2.8	-
4. IAS/Policy			
4.1 Creation of policies	1.F	2.1	1.6
4.2 Maintenance of policies	1.F	2.1	1.6
4.3 Prevention	1.J	2.7	1.6
4.4 Avoidance	1.J	2.7	1.6
4.5 Incident response (forensics)	7.G	2.4	1.6
4.6 Domain integration	7.D	1.1-2 / 2.7	1.6
5. IAS/Attacks			
5.1 Social engineering	1.J	3.3	9.1-6 / 2.3
5.2 Denial of Service	7.H	3.2	10.1-8
5.3 Protocol attacks	4.A	3.2	8.1 / 8.4
5.4 Active attacks	-	3.7	5.4 / 8.1
5.5 Passive attacks	-	3.7	5.4 / 8.1
5.6 Buffer overflow attacks	8.B	3.5	13.2 / 13.5 / 14.1-9 / 18.1-7
5.7 Malware	7.H	3.1	6.1-7 / 7.1-6
6. IAS/Security Domains			
6.1 Security awareness	1.L	1.4 / 2.2	1.1 / 13.1-2
7. IAS/Forensics			
7.1 Legal systems	2.F / 7.B	2.4	-
7.2 Digital forensics and its relationship to other forensic disciplines	7.A	2.4	-
7.3 Rules of evidence	7.A	2.4	-
7.4 Search and seizure	2.F / 7.B	2.4	-

ACM IAS Guideline for Information Technology	CISSP	Security+ SY0-401	CEH 312-50
7.5 Digital evidence	7.A	2.4	-
7.6 Media analysis	2.A / 7.A / 7.F	2.4	-
8. IAS/Information States			
8.1 Transmission	4.B	4.4	-
8.2 Storage	4.B	4.4	-
8.3 Processing	4.B	4.4	-
9. IAS/Security Services			
9.1 Confidentiality, Integrity, Availability	1.A / 3.A	2.9	1.1
9.2 Authentication	5.A-B, E	5.2	1.6 / 5.4
9.3 Non-repudiation	3.I	2.9 / 6.1	1.1
10. IAS/Threat Analysis Model			
10.1 Risk assessment	1.I	2.1 / 4.5	-
10.2 Cost benefit	1.I	2.1	-
11. IAS/Vulnerabilities			
11.1 Perpetrators	1.J	3.2-5	1.3
11.2 Inside attacks	1.J	3.2-5	9.2
11.3 External attacks	1.J	3.2-5	1.3
11.4 Black hat	-	3.8	1.3
11.5 White hat	-	3.8	1.3
11.6 Ignorance	-	3.8	-
11.7 Carelessness	-	3.8	-
11.8 Network	4.D	1.5 / 3.4,6	3.1-2
11.9 Hardware	7.D	4.3	5.4
11.10 Software	8.B	4.1	5.4
11.11 Physical access	7.O	2.7,9	-

Table 6 – Mapping ACM 2008 IT Curricula Guidelines and security certification requirements

CISSP Domains	% KA's Linked to ACM IT IAS Guideline
Security & Risk Management (CISSP Domain 1) – 12 KA's	58%
Asset Security (CISSP Domain 2) – 6 KA's	50%
Security Engineering (CISSP Domain 3) – 11 KA's	54%
Communication & Network Security (CISSP Domain 4) – 4 KA's	75%
Identity and Access Management (CISSP Domain 5) – 7 KA's	43%
Security Assessment and Testing (CISSP Domain 6) – 5 KA's	40%
Security Operations (CISSP Domain 7) – 16 KA's	63%
Software Development Security (CISSP Domain 8) – 4 KA's	25%

Table 7 - Percent of CISSP Domain KA's linked to ACM IAS Guideline

Security+ Domains	% KA's Linked to ACM IT IAS Guideline
Network Security (Security+ Domain 1) – 5 KA's	100%
Compliance and Operational Security (Security+ Domain 2) – 9 KA's	100%
Threats and Vulnerabilities (Securtiy+ Domain 3) – 8 KA's	100%
Application, Data, and Host Security (Security+ Domain 4) – 5 KA's	100%
Access Control and Identity Management (Security+ Domain 5) – 3 KA's	100%
Cryptography (Security+ Domain 6) – 3 KA's	100%

Table 8 - Percent of Security+ Domain KA's linked to ACM IAS Guideline

Certified Ethical Hacker Modules	% KA's Linked to ACM IT IAS Guideline
Introduction to Ethical Hacking (CEH Module 1) – 6 KA's	67%
Foot printing and Reconnaissance (CEH Module 2) – 6 KA's	17%
Scanning Networks (CEH Module 3) – 2 KA's	100%
Enumeration (CEH Module 4) – 11 KA's	0%
System Hacking (CEH Module 5) – 4 KA's	25%
Trojans and Backdoors (CEH Module 6) – 7 KA's	100%
Viruses and Worms (CEH Module 7) – 6 KA's	100%
Sniffers (CEH Module 8) – 9 KA's	22%
Social Engineering (CEH Module 9) – 6 KA's	100%
Denial of Service (CEH Module 10) – 8 KA's	100%
Session Hijacking (CEH Module 11) – 5 KA's	0%
Hacking Webservers (CEH Module 12) – 8 KA's	0%
Hacking Web Applications (CEH Module 13) – 7 KA's	43%
SQL Injection (CEH Module 14) – 9 KA's	100%
Hacking Wireless Networks (CEH Module 15) – 9 KA's	0%
Hacking Mobile Platforms (CEH Module 16) – 8 KA's	0%
Evading IDS, Firewalls and Honeypots (CEH Module 17) – 8 KA's	25%
Buffer Overflows (CEH Module 18) – 7 KA's	100%
Cryptography (CEH Module 19) – 8 KA's	100%
Penetration Testing (CEH Module 20) – 6 KA's	17%

Table 9 - Percent of CEH Module KA's linked to ACM IAS Guideline

ACM IT IAS Guideline	% of ACM IT KA's Tested		
	CISSP	Security+ SY0-401	CEH 312-50
IAS/Fundamental Aspects	100%	100%	63%
IAS/Security Mechanisms	100%	100%	75%
IAS/Operational Issues	88%	100%	38%
IAS/Policy	100%	100%	100%
IAS/Attacks	71%	100%	100%
IAS/Security Domains	100%	100%	100%
IAS/Forensics	100%	100%	0%
IAS/Information States	100%	100%	0%
IAS/Security Services	100%	100%	100%
IAS/Threat Analysis Model	100%	100%	0%
IAS/Vulnerabilities	64%	100%	73%

Table 10 – Percent of ACM IT Guidelines covered by popular certifications

Protecting Privacy in Big Data: A Layered Approach for Curriculum Integration

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Abstract

The demand for college graduates with skills in big data analysis is on the rise. Employers in all industry sectors have found significant value in analyzing both separate and combined data streams. However, news reports continue to script headlines drawing attention to data improprieties, privacy breaches and identity theft. While data privacy is addressed in existing information system (IS) programs, greater emphasis on the significance of these privacy issues is required as big data technology advances. In response to this demand, some colleges and universities are developing big data programs and degrees (Gupta, Goul & Dinter, 2015). Yet not every university has the resources to allow for such expansion; some institutions struggle just to cover their IS core program courses. For these latter programs, awareness of the importance of privacy and privacy methods—like the application of security controls—is best integrated academically through a layered approach. Therefore, in this paper, the authors illustrate the important role that data privacy plays in the realm of big data, and suggest methods for providing a layered approach to applying big data privacy concepts to the IS2010 Model Core Curriculum.

Keywords: Big Data, Privacy, Teaching Methods, IS2010 Model Curriculum

1. INTRODUCTION

The ever-increasing capabilities of technology to access, collect, disseminate and manipulate growing stores of data are opening new doors for researchers, industries, businesses and…cybercriminals. Proper application of big data analysis has the potential to improve accuracy, timeliness, and relevance of corporate operations (Landefeld, 2014). However, future employees need to be aware of the critical role of data privacy in every organization's analysis of big data, as well as the consequences that may ensue if efforts are not reasonably made to protect confidentiality. In this article, the authors describe the need for privacy awareness among students in the expanding world of big data and, using the IS2010 Model Curriculum Guidelines, suggest areas in which big data privacy methods can be incorporated into the curriculum to provide a constant reminder of the significant role that privacy plays in organizations' future success or failure.

2. BIG DATA AND PRIVACY: "FIRST, DO NO HARM."

"Information is the oil of the 21st century, and analytics is the combustion engine." - Peter Sondergaard, Senior Vice President, Gartner Research

Background

They all agreed it was a great idea—the creation of an open source software program to "safely organize, pool, and store student [K-12] data from multiple states and multiple sources in the cloud" (Kamenetz, 2014, para. 2). Such a big data system would revolutionize student learning throughout the country, and promote educational progress on many levels. The planned program, organized within the not-for-profit company inBloom, Inc., would include "everything from demographics to attendance to discipline to grades to the detailed, moment-by-moment, data produced by learning analytics programs like Dreambox and Khan Academy" (Kamenetz, 2014, para. 2). The data could be accessed by educators through an application-programming interface (API), essentially making the information universally available to any school, with only minimal inputs. In 2011, the Bill and Melinda Gates Foundation got behind the project, dedicating over $87 million to develop the shared learning infrastructure. It was an educators' dream come true.

inBloom's Downfall

As the company moved forward with the project, it partnered with nine states representing 11 million students: Colorado, Delaware, Georgia, Illinois, Kentucky, Louisiana, Massachusetts, New York and North Carolina (Kamenetz, 2014). But shortly after collaboration began, the shared big data dream began descending into an unexpected privacy nightmare. It was reported by Reuters that the $100 million database held files where "millions of children [were identified] by name, address and sometimes social security number. Learning disabilities [were] documented, test scores recorded, attendance noted. In some cases, the database tracked student hobbies, career goals, attitudes toward school—even homework completion" (Simon, 2013, para. 3). And although local education officials retained control over their respective students' information, federal law would allow them to "share files in their portion of the database with private companies selling educational products and services" (Simon, 2013, para. 4).

Parents in the partnership states were astounded at both the type of data collected and its handling; a firestorm of protests against the system began in Louisiana, Colorado and New York. As a result, inBloom spent the majority of their project development days addressing privacy concerns and attempting to keep their state partners in the program. The company's initial policy statement did little to aid in their battle: "inBloom, Inc. cannot guarantee the security of the information stored in inBloom or that the information will not be intercepted when it is being transmitted" (Madda, 2014, para. 19). Louisiana was the first state to back away from the inBloom database when "State Superintendent John White agreed to pull student data out…in April, 2013. By August 1, 2013, five of inBloom's state partnerships were kaput" (Madda, 2014, para. 21). A few months later, with no remaining partners, the company announced the end of the project (Bogel, 2014).

The rise and fall of inBloom's big data project was directly related to the measure of privacy (or lack thereof) afforded by the database. While most would agree that big data provides for a better understanding of information critical to the success of modern businesses and our broader society, it is also clear that the increasing need for privacy is a forefront concern. With over 40% of mid-market businesses already engaged in one or more big data projects, and another 55% of businesses contemplating a project in the near future, it is important that information technology students become familiar with big data privacy issues (Dell, 2014). Up-and-coming information systems managers would do well to ignore Facebook founder Mark Zuckerberg's sentiment that "Privacy is dead"—at least where big data is involved (Craig & Ludloff, 2011).

Incorporating Privacy into the Curriculum

This paper describes the need for privacy in the expanding world of big data, as well as a review of the methods that are currently available to protect such privacy. Although some universities are addressing the commercial need for Big Data analysis skills by creating new courses and programs, many institutions require a more conservative option. The authors therefore suggest integrating expanded big data privacy concepts into the IS 2010 Model Core Curriculum using a layered approach. This approach allows existing courses to highlight these very important privacy concepts without overwhelming an already substantial curriculum base.

The value of training information technology students in privacy procedures parallels the importance of other critical big data records management techniques. In the May 2014 report "Big Data and Privacy: A Technological Perspective," U.S. Presidential Science and Technology Advisors recommended the expansion of education in the area of big data and privacy, hoping to "accelerate the development and commercialization of technologies that can help to contain adverse impacts on privacy, including research into new technological options.

By using technology more effectively, the Nation can lead internationally in making the most of big data's benefits while limiting the concerns it poses for privacy" (President's Council of Advisors on Science and Technology, 2014, p. 9).

3. BIG DATA AND PRIVACY: WHAT'S THE "BIG" DEAL?

The benefits of big data are proving to be highly valuable; businesses have been able to profile and target consumers, redevelop more marketable products, create new revenue streams, and reduce maintenance costs—all in record time (Dataseries, 2012). But as with any fast-growing technology, there are associated risks. Privacy issues have been identified as a primary risk; and the mismanagement of big data with respect to privacy may also result in loss of compliance and other regulatory problems as well (Tobin, 2013). Privacy scholars have also discussed a second risk closely associated with big data privacy: potential discrimination (Rubenstein, 2012). Michael Schrage, in a Harvard Business Review article, points out "in theory and practice, big data digitally transmutes cultural clichés and stereotypes into empirically verifiable data sets. But the law, ethics and economics leave unclear where value-added personalization and segmentation end, and harmful discrimination begins" (Schrage, 2014, para. 10).

In a report by the Massachusetts Institute of Technology (MIT), Georgetown University Law Professor David Vladeck discusses what some believe is the greatest privacy risk associated with collected big data, that "consumers will suffer 'discrimination by algorithm', or a kind of data determinism, because correlation will lead individuals to be categorized . . . [based on] general trends that will be seen as sufficiently robust to draw conclusions about their individual behavior, often with no process for mitigation if the conclusion is wrong" (MIT Workshop, 2013, p. 8). White House Science and Technology Advisors echoed this concern in their own report, citing "data analytics discovers patterns and correlations in large corpuses of data, using increasingly powerful statistical algorithms. If those data include personal data, the inferences flowing from data analytics may then be mapped back to inferences, both certain and uncertain, about individuals" (PCAST, 2014, p. x).

Even if the data interpretations are valid, the use of such data can lead to personal harm. The Presidential advisors present in their report some actual and potential examples of big data applications and their inferred privacy concerns:

- "The UK firm FeatureSpace offers machine-learning algorithms to the gaming industry that may detect early signs of gambling addiction or other aberrant behavior among online players.
- By tracking cell phones, RetailNext offers bricks-and-mortar retailers the chance to recognize returning customers, just as cookies allow them to be recognized by on-line merchants. Similar WiFi tracking technology could detect how many people are in a closed room (and in some cases their identities).
- The retailer Target inferred that a teenage customer was pregnant and, by mailing her coupons intended to be useful, unintentionally disclosed this fact to her father.
- The author of an anonymous book, magazine article, or web posting is frequently "outed" by informal crowd sourcing, fueled by the natural curiosity of many unrelated individuals" (PCAST, 2014, p. 12).

Numerous factions report that big data privacy concerns are especially prominent in healthcare and education, where the greatest potential for discrimination may be lurking (PCAST, 2014). White House Advisors noted in healthcare big data that "large-scale analysis of research on disease, together with health data from electronic medical records and genomic information, might lead to better and timelier treatment for individuals, but also to inappropriate disqualification for insurance or jobs." The report also disclosed with regard to education that "knowledge of early performance can create implicit biases that color later instruction and counseling. There is great potential for misuse, ostensibly for the social good, in the massive ability to direct students into high- or low-potential tracks."(p. 14) The latter application of big data was likely a concern of the inBloom database parents and detractors—narrowing students' potential opportunities, possibly without their awareness, and certainly without consent.

4. BIG DATA AND PRIVACY: WHAT'S AN IT MANAGER TO DO?

Robert Zandoli, SVP and Global Chief Information Security Officer for AIG suggests that in order to protect privacy, the information systems manager should understand the life cycle of big data, which he separates into five phases:

- **Collection**–What kind of data is being collected? Is it reliable and secure?
- **Storage**–How is the data being stored? Where and with what type of protection?
- **Uses/Users**–How is the data being used and by whom?
- **Transfer**–How is the data being moved? Where is it going and is the transfer being done securely?
- **Destruction**–What are the data retention cycles? Who decides when to destroy the data and how will the destruction take place? (MIT Workshop, 2013).

In addition to the life cycle, individuals working in IS should also be familiar with the nature of privacy concerns. Steve Landefeld broke data privacy concerns into two groups in a paper presented at the UN sponsored 2014 *International Conference on Big Data for Official Statistics*:

Individual concerns are associated with "…disclosure of detailed personal medical, financial, legal or other sensitive information that would lead to discriminatory outcomes and uses for tax, investigation, legal and other government purposes." (2014, p. 15)

Business concerns are associated with the "…release of commercially valuable marketing and other data sets; propriety information on the methods and sources used to produce those data; disclosure to competitors of important strategic information on pricing, costs, profits, and markets; and the use of such information for tax, regulatory, investigation, legal and other purposes." (2014, p. 15-16)

Also important is the knowledge that analysis of big data compounds privacy issues as the phenomenon of data fusion brings additional privacy issues to the forefront. Individually, separate data streams may be adequately protected and kept confidential; however, when the streams are combined, emergent properties may present further privacy challenges (PCAST, 2014).

After IT personnel understand the way in which big data is managed and privacy concerns are categorized, they can address the issues of the indiscriminate or over-collection of big data, as well as the ever-present concerns about breaches of the systems intended to protect the collected information. The dual problem, then, for the information systems manager, is the collection of the appropriate data coupled with its security.

With regard to security of collected big data, it is important for information systems professionals to think not just in terms of cybersecurity when protecting privacy, but to focus their considerations on privacy policy and data use. Because even "if there were perfect cybersecurity, privacy would remain at risk. Violations of privacy are possible even when there is no failure in computer security. If an authorized individual chooses to misuse (e.g., disclose) data, what is violated is privacy policy, not security policy" (PCAST, 2014, p. 34).

Privacy Protection Methods

Therefore, to ensure the best protection for big data privacy in terms of collection, usage, and security, information technology students should be familiarized with current methods of protection. Beginning in 1996, the ISACA COBIT framework (Information Systems Audit and Control Association) (Control Objectives for Information and Related Technology) provided a comprehensive and systematic approach for managing and controlling information systems using a series of layered controls. COBIT 5 incorporates multiple frameworks including ISACA's Val IT (Value from IT Investments) and Risk IT, Information Technology Infrastructure Library (ITIL) and related International Organization for Standardization (ISO) standards (ISACA, 2015).

Another (previously mentioned) document that can provide guidance was created by The President's Council of Advisors on Science and Technology in 2014 entitled "Big Data and Privacy: A Technological Perspective" (PCAST, 2014). Both documents provide timely suggestions for privacy measures that can be incorporated throughout IS program coursework. Several of these privacy measures are described in Section 5, "Big Data and Privacy: A Layered Approach."

5. BIG DATA AND PRIVACY: INCORPORATING IT INTO THE CURRICULUM

The drive to produce graduates with big data skills is growing (Gorman & Klimberg, 2014). Gupta, Goul and Dinter (2015) recently described a model curriculum for Business Intelligence (BI) and Analytics electives. In developing their model, the authors surveyed IS faculty to determine the extent to which BI content was being implemented in classes. The authors found that Business Intelligence (BI) courses have gained relevance on campuses (Gorman & Klimberg, 2014) and that more departments offer the courses as electives rather than as core courses (Gupta, Goul, & Dinter, 2015).

Gorman & Klimberg (2014) found that a majority of data analytics programs are found in business departments that combine Decision Sciences and Management Information Systems. However, not all colleges and universities are able to devote academic resources specifically for data analytics courses at this time. Instead, data analytics concepts and exercises are being incorporated into existing classes (Chen, Liu, Gallagher, Pailthorpe, Sadiq, et. al, 2012; Frydenberg, 2015). Thus, specific concepts, such as big data privacy protection may be skirted or overlooked. As future overseers of corporate data and information systems, it is important that IS students are not only aware of big data analytics, but that they also are familiar with keeping data private and using it appropriately. "Big data actually has a tremendous potential to solve some huge societal problems," stated FTC Commissioner Julie Brill at a recent Aspen Ideas Festival, [but] "I don't think any of these potential benefits are going to be realized until we solve the privacy issues." (Whiteman, 2014, para. 4).

IS2010 Curriculum Guidelines

In the Executive Summary of the IS 2010 Curriculum Guidelines, the authors note that the document's revision was shaped with the understanding that "… the curriculum reaches beyond the schools of business and management. "(p. vii) In addition, the document notes that the highest-level outcomes that the curriculum is expected to include are:

- Improving organization processes
- Exploiting opportunities created by technology innovations
- Understanding and addressing information requirements
- Designing and managing enterprise architecture
- Identifying and evaluating solution and sourcing alternatives
- Securing data and infrastructure, and
- Understanding, managing and controlling IT risks. (p. vii)

Thus, the framework was developed as a "living curriculum" that could adapt and transform to the changing environment. The dynamic nature of the model curriculum is especially valuable when you consider the expanding uses of big data in disciplines where privacy is essential, such as healthcare management. With that in mind, the next section describes how big data privacy concepts can be incorporated into the existing IS2010 Model Curriculum.

6. BIG DATA AND PRIVACY: A LAYERED APPROACH IN THE IS2010 MODEL CURRICULUM

Because protecting privacy in big data analytics is extremely important and there is a limited amount of resources (class time and faculty) to apply to teaching specific big data concepts, the authors suggest taking a cue from the COBIT model and applying a layered approach to covering big data privacy protection concepts throughout the Model Curriculum. In this section, the authors describe big data privacy concepts and suggest IS2010 courses (Table 1) in which concept coverage might be appropriate based upon the learning objectives of the course (Appendix).

IS2010.1	Foundations of IS
IS2010.2	Data and Information Management
IS2010.3	Enterprise Architecture
IS2010.4	Project Management*
IS2010.5	IT Infrastructure
IS2010.6	Systems Analysis and Design
IS2010.7	IS Strategy, Management, and Acquisition

Table 1. IS2010 Model Curriculum
* Big data privacy concepts were not suggested for incorporation into IS2010.4.

A culture of confidentiality needs to be fostered and reinforced by top level management and the organization's objectives. Employees should be regularly reminded of the company's stance on data privacy. (IS2010.1, 2, 3 & 7)

Reliable employees with proficient skills, clean background checks, and a history of honesty and integrity should only be allowed to access confidential data. (IS2010.2, 3 & 7)

A Data Governance Board can oversee the development, implementation, and adherence of data privacy policies. (IS2010.1, 2, 3, 6 & 7)

Written Policies and Procedures, specifically for big data access, storage, usage, confidentiality, governance, and policy violations, should be developed, signed, and accessible for employee review. Policy documents should be regularly updated and revised with employees commonly made aware of the policy changes. Employees should be asked to read and renew their acceptance of updated privacy policies each year (IS2010.2, 3, 5, 6 & 7)

Physically protecting the data from unauthorized access through a layered approach of physical controls such as the choice of data storage locations, multiple locked doors, and human gatekeepers. (IS2010.2, 3, 5, 6 & 7)

Authorized and authenticated access to the data through logins and passwords, biometric controls and password policies. (IS2010.1, 2, 3, 5, 6 & 7)

Anonymization and De-identification methods are often used to mask the data provider's identity. However with the glut of available data, the benefits of these methods can easily be nullified (PCAST, 2014). (IS2010.2, 3, 5, 6 & 7)

Encryption and digital signatures are usually standard topics addressed in Introductory MIS textbooks. However, further discussion of those topics might include (1) end-to-end encryption and limiting the amount of time that data to be encrypted is stored in an unencrypted format, (2) limiting access to unencrypted data, (3) policies to ensure that confidential data is kept protected and private, (4) use of different types of encryption keys such as identity- or attribute-based encryption, and (5) recent developments for data privacy protection (PCAST, 2014). (IS2010.1, 2, 3, 5, 6 & 7)

Reduce exposure: In a report published by the Sans Institute regarding the Target credit card breach of 2013, the report indicates that the attackers might have used simple Google searches to conduct reconnaissance on Target. Information that the attackers could have easily found include material regarding Target's vendor portal and some of the vendors in which they interact, as well as a detailed case study describing Target's use of virtualization software, their technical infrastructure, detailed Point of Sale system information and information regarding their security patches and system updates deployment system (SANS, 2014).

In protecting data from leaking and systems from being breached, companies need to limit exposures and vulnerabilities and approach describing their systems and data structures on a "need to know basis." (IS2010.2, 3 & 7)

Differential Privacy and "Noising" techniques can be used to obfuscate the data and confuse the reader should the data be breached. (IS2010.2, 3. 5, 6 & 7)

Deletion and Non-Retention polices are beneficial, but not foolproof as data may be stored in multiple locations. Retained data streams can be stored separately in an anonymized and encrypted format on password protected storage. (IS2010.1, 2, 3, 5 & 7)

Notice and Consent provision at each point in the data collection process should be emphasized to distribute the privacy burden to the data providers. (IS2010.2, 3, 6 & 7)

Management of data access and usage logs should be handled on regular basis. Policies for handling observed issues and violations should be followed and strictly enforced. (IS2010.2, 3, 5 & 7)

A summary of the IS2010 course objectives and the big data privacy methods that could be addressed in those courses are outlined in the appendix. Due to time restrictions, faculty will want to select concepts from the list of those suggested.

7. CONCLUSIONS

Although privacy concepts have been addressed in IS courses, the need to emphasize those topics in light of rising data breaches and big data analytics is becoming increasingly apparent. Both The President's Council of Advisors on Science and Technology and ISACA's COBIT framework provide a detailed collection of data privacy measures that can be incorporated into coursework and applied in the field. However, incorporating privacy concepts into course material that is specific to big data analytics, is met with restrictions. In this paper, the authors propose a layered approach to addressing data privacy methods by incorporating multiple methods throughout the IS2010 Model Curriculum.

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Appendix

Core Curriculum	Learning Objective	Privacy Protection Measures
IS2010.1 Foundations of Information Systems	7. Mitigate risks as well as plan for and recover from disasters. 10. Understand how various types of IS provide the information needed to gain business intelligence to support the decision making for the different levels and functions of the organization. 11. Understand how enterprise systems foster stronger relationships with customers and suppliers and how these systems are widely used to enforce organizational structures and processes. 13. Understand how to secure information systems resources, focusing on both human and technological safeguards. 14. Evaluate the ethical concerns that information systems raise in society and the impact of information systems on crime, terrorism, and war.	• Culture of confidentiality • Data Governance Board • Physical protection • Authorized & authenticated access • Encryption & digital signatures • Deletion & non-retention policies
IS2010.2 Data and Information Management	3. Understand the basics of how data is physically stored and accessed. 17. Understand the key principles of data security and identify data security risk and violations in data management system design.	• Culture of confidentiality • Reliable employees • Data Governance Board • Written Policies & Procedures • Physical protection • Authorized & authenticated access • Anonymization & de-identification methods • Encryption & digital signatures • Reduce exposure • Differential privacy and "noising" techniques • Deletion & non-retention policies • Notice & consent • Management of data access & usage logs
IS2010.3 IS Enterprise Architecture	3. Utilize techniques for assessing and managing risk across the portfolio of the enterprise. 4. Understand the benefits and risks of service oriented architecture.	• Culture of confidentiality • Reliable employees • Data Governance Board • Written Policies & Procedures • Physical protection • Authorized & authenticated access • Anonymization & de-identification methods • Encryption & digital signatures • Reduce exposure

		• Differential privacy and "noising" techniques • Deletion & non-retention policies • Notice & consent • Management of data access & usage logs
IS2010.5 IT Infrastructure	2. Understand the principles of underlying layered systems architectures and their application to both computers and networks. 14. Analyze and understand the security and business continuity implications of IT infrastructure design solutions. 15. Configure simple infrastructure security solutions.	• Written Policies & Procedures • Physical protection • Authorized & authenticated access • Anonymization & de-identification methods • Encryption & digital signatures • Differential privacy and "noising" techniques • Deletion & non-retention policies • Management of data access & usage logs
IS2010.6 Systems Analysis and Design	11. Incorporate principles leading to high levels of security and user experience from the beginning of the systems development process. 13. Analyze and articulate ethical, cultural, and legal issues and their feasibilities among alternative solutions.	• Data Governance Board • Written Policies & Procedures • Physical protection • Authorized & authenticated access • Anonymization & de-identification methods • Encryption & digital signatures • Differential privacy and "noising" techniques • Notice & consent
IS2010.7 IS Strategy, Management, and Acquisition	1. Understand the various functions and activities within the information systems area, including the role of IT management and the CIO, structuring of IS management within an organization, and managing IS professionals with the firm. 2. View an organization through the lens of non-IT senior management in deciding how information systems enable core and supportive business. 8. Understand existing and emerging information technologies, the functions of IS and its impact on the organizational operations.	• Culture of confidentiality • Reliable employees • Data Governance Board • Written Policies & Procedures • Physical protection • Authorized & authenticated access • Anonymization & de-identification methods • Encryption & digital signatures • Reduce exposure • Differential privacy and "noising" techniques • Deletion & non-retention policies • Notice & consent • Management of data access & usage logs

Developing Project Based Learning, Integrated Courses from Two Different Colleges at an Institution of Higher Education: An Overview of the Processes, Challenges, and Lessons Learned

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Abstract

All too often, courses in higher education tend to teach isolated bits of facts with little effort to assist in learner assimilation of those facts so as to grow knowledge of the world into a more dynamic understanding. To address the need for a capstone research project for students in their master's program and in an effort to create online courses which offer a more meaningful learning environment with integrated curriculum, two professors chose to accomplish this by combining their courses over a two-semester period of time. An additional challenge existed since these two courses were in two separate departments (Computer Science and Curriculum & Instruction), and in two different colleges (College of Sciences and College of Education) on a university campus. This article explains why they chose project based learning as the foundation for merging these courses. Further, it describes the process, the assignments, the challenges, and the lessons learned.

Keywords: Integrated Curriculum, Distance Education, Project Based Learning, Instructional Technology, Capstone Research Project.

1. INTRODUCTION

In the world of instructional technology, course content does not stay the same over time. With the array of tools and resources available, and changing, over time, it is necessary to adjust/adapt courses in order to remain pertinent. That is certainly the case with the faculty of the Master's in Instructional Technology Program (MIST) at Sam Houston State University. Although we modify courses each semester within our existing standards to address the changing technologies, when the industry standards themselves change, it provides an opportunity to review an existing curriculum and determine what changes must be made in order to address these new standards.

A recent change in the International Society for Technology in Education organization's alignment of standards from Technology Facilitators to Technology Coaches prompted a juncture in time to review the curriculum in the Masters of Instructional Technology Program. With the program being a unique combination of curriculum between the Department of Curriculum and Instruction in the College of Education and the Department of Computer Science in the College of Sciences, our collaboration seems to be more intentional, intellectual, and philosophically engaging than curriculum discussions involved within only one department. Whether the result of this faculty sharing the same ideals about our area of focus or whether it is the fact that we approach it with the knowledge that we are two departments in different colleges so we sub-consciously come to the meeting recognizing our differences and expecting discussion and compromise, the situation seems to benefit the students of the program by resulting in a better curriculum and better learning opportunities for them.

It was determined that curriculum in the first four semesters of the program would present foundational assignments that taught teaching philosophies, theories, and smaller "practice" applications of skills learned. The last two semesters, which are the fourth and fifth semesters, would then allow the opportunity for students to demonstrate their mastery of virtually all of the standards the entire program aimed to address. With that decided, the two faculty members teaching those last four courses began the journey to determine how to turn that plan into a curriculum.

Since we both had been putting at least some elements of Project Based Learning (PBL) in our courses in the past and were striving to do more of it, we began to plan that direction.

2. WHY PROJECT BASED LEARNING?

As the early authors in instructional technology attempted to tell us what makes the foundation for good instruction when using technology, we begin to see a trend in similarities. Although the same wording is not used, the meanings of what they list as the most important elements to include in instructional technology are very much the same, as seen below:

Since project based learning falls along the learning theory continuum more toward the end of the constructivism scale, those authors who wrote about technology and constructivism helped to lay the foundation. As an example, Bednar, Cunningham, Duffy, and Perry (1991), early on in the emergence of instructional technology, explained that "instructional design emerges from the deliberate application of some particular theory of learning (p. 102)." Written from their view of constructivism, they went on to describe a constructivist's assumptions that are consistent with beliefs in this learning theory:

1. Situated Cognition in real-world contexts
2. Teaching through cognitive apprenticeship
3. Construction of multiple perspectives

Moursund (2003) advocates for project based learning, saying that it has a high level of "authenticity" (p. xi). He points out that an information technology-assisted PBL lesson is an opportunity for students to:

1. Learn in an authentic, challenging, multidisciplinary environment
2. Learn how to design, carry out, and evaluate a project that required sustained effort over a significant period of time
3. Learn about the topics on which the project focuses
4. Gain more information technology knowledge
5. Learn to work with minimal external guidance, both individually and in groups
6. Gain in self-reliance and personal accountability

He also points out that information technology helps "create a teaching and learning environment in which students and teachers are both learners and facilitators of learning – that is, they function as a community of scholars (p. xi)." Jonassen et al (2008) describes the characteristics of Meaningful learning:

1. Active (Manipulative/Observant) Learning
2. Constructive (Articulative/Reflective)
3. Intentional (Goal-Directed/Regulatory)
4. Authentic (Complex/Contextual)
5. Cooperative (Collaborative/Conversational)

Jonassen says that learning results from thinking and points out the different ways of thinking that are fostered by the use of technology:

1. Causal
2. Analogical
3. Expressive
4. Experiential
5. Problem Solving

Why would students be interested in learning in a project based format? According to Daniel Pink, in our current "traditional" educational system of today, we are "bribing students into compliance instead of challenging them into engagement (p. 185)." It is no coincidence that the lists of important elements from each of the instructional technology authors above can all be compared and subsumed under and within Daniel Pink's list of elements that describe a Type I (intrinsically motivated) personality:

1.Autonomy
2.Mastery
3.Purpose

We have been told for years, by various theorists, educators, and authors from various walks of life that we need more engaging, autonomous, authentic, cooperative learning processes in our formal educational institutions. Fischer (2015) echoed that process is important in student-driven group projects where the primary goal may be cooperative learning. We've just chosen to not listen and put it all together. (Or, perhaps, like many of our graduate students, they don't read, so nobody is making the connections!)

Listening to what Bednar, et al., Moursund, Jonassen, and Pink say above, along with considering Bednar, et al. indicated that instructional design developers must first be aware of their personal beliefs about learning and "select concepts and strategies from those theories that are consistent with those beliefs (p. 102)", we two instructors looked within ourselves to ensure that we understood and aligned our instructional development with our beliefs about what is the best theory of learning for our content. We wished for our students to not simply learn isolated materials and skills, but to actively apply and work with that knowledge and skills in real-world situations. It was also a goal of ours to help our students become intrinsically-motivated, independent researchers and thinkers. As technology has been viewed to provide a more authentic context than traditional classrooms could afford (Cifuentes & Ozel, 2009), we wanted to prepare our students to be not only the ones who simply lead technology integration into instruction, but the change-agents who also model how to do this in an authentic, multi-disciplinary environment where learners have opportunities to practice critical thinking, problem solving, and effective communication skills. At the same time, influenced by Boss and Krauss (2014) who said that "deeper learning" gets at the increased academic rigor to gain traction to describe the multifaceted outcomes of project-based learning, we acknowledged that our philosophies of how students learn best were the foundational elements of project based learning. In addition, our experiences with PBL in this program and other courses had led us to recognize the positive impact PBL has on the delivery of our instruction. Thus, this was our main motivation to accept the challenge to integrate our courses into this process.

Although we felt that the information provided by these authors in instructional technology was justification enough to design our instruction in the project based learning format, there were also other important reasons to consider; and these helped support our philosophy of engaged learning as the center of instruction:

1.The practical framework of project-based learning has been continually growing in K-12 schools across America over the past few decades, and making a significant impact (Fischer, 2015). Eventually, those students will expect to learn that way in the higher education venue.

2.Project based learning demonstrates how to meaningfully integrate technology into the classrooms. As the carefully designed project is carried out by the learners, the seamless use of technology at the appropriate junctures best demonstrate what we mean by "meaningful implementation of technology".

3.Boss (2015) emphasized that action projects actually put students' ideas to work. Seeing their ideas in action can provide the confidence and encouragement for students to become more active citizens. What better way to facilitate the implementation of action projects among our K-16 schools and enterprises' practices than preparing our technology coaches to model how it's done? This accomplishes what Schwering (2015) tells us is expected by employers: graduates can actually integrate and apply what they have learned into real world applications.

3. THE PROCESS

All authors referenced above talked about what needed to be included in the instructional process when designing the integration of technology into the curriculum. Using the elements of PBL by Buck Institute for Education (2011), we developed the instruction so that the following elements were embedded within the design of the project: Driving Question, Need to Knows, Inquiry, Voice and Choice, Reflection & Revision, and Authentic Public Audience, all based on the foundation of the Significant Content and designed to give the students an opportunity to practice and learn Critical Thinking, Collaboration, and Communication.

To begin, we had to focus on ensuring that our students showed evidence that they had mastered the program standards (PBL Significant Content). That began the process that resulted in a chart that identified the:

1. Objectives (Overall)
2. Objectives (As addressed by each course)
3. Resource and Strategy Suggestions (For each course)

Since some objectives were taught in both courses while some objectives were taught only in one course, we felt it necessary to design a visual that could easily describe for our students where those objectives were being taught and where they could expect to see these objectives as criteria in their assignment rubrics. An example of the chart can be found in the Appendix below.

After designing this chart to include all of the objectives and where those objectives would be taught, we began to brainstorm how we could design a driving question that would be the guiding query for our students over the next two semesters. A critical opening to establish a learning opportunity, the driving question had to be broad enough to cover all objectives, but narrow enough so that the students could continue to focus on it as they went through the two semesters. The decision was made to present the driving question (PBL Driving Question) as follow:

"How do you, as a Technology Coach, demonstrate mastery of the knowledge, skills, and dispositions required in order to achieve the role of a transformational change agent in the organization?"

This began the students' journey. They were guided, first, by the instructors' carefully designed chart communicating the objectives, with the "Resources/Strategies" column revealing possible methods to use to master the objectives. In addition, each professor developed her own written assignment, as necessary, describing in full detail how the mastery of objectives were assessed in that course. Where appropriate, the professors shared the same Rubric. When the expectations differed too much, two different Rubrics were developed to better clarify for the students the expectations for each course. Nevertheless, the "Project" remained common for both courses in tandem so that, as the students moved through the semesters, their end results would address the expectations of both courses.

4. SEMESTER 4 IN THE PROGRAM

In an attempt to bring an overwhelming amount of knowledge to learn into a format of "assignments", we found that this chart easily fit into two areas. The first part of it held objectives that led students to discover the instructional training needs of their organizations, while the second part focused more on designing a training package for their organizations. Thus, we referred to the two big areas of the semester as the "Needs Analysis" and the "Training Package". There, of course, were work expectations within each of these, but breaking the semester down between these two areas helped the students as they worked their way through this project. In each element listed below, the students addressed the criteria from both the (1) Infrastructure/Hardware and the (2) Instructional/Curriculum perspectives.

Needs Analysis (PBL Inquiry):

a. Research conducted to identify the organization's Technology Goals
b. Conducting the Technology Analysis
c. Analyzing the Current Status of the Organization and its learners and its progress toward the achievement of its technology goals

Once the Needs Analysis was completed, the students then Developed and Designed Objectives (PBL Significant Content) for the Organization's Training. These would guide them as they developed the various parts of the Training Package.

Training Package (PBL Authentic Public Audience):

a. Development of your Assessment Instruments
b. Researching and developing the Funding and Management strategy for the Training
c. Developing the Training Package itself
d. Evaluating with Training Package
e. Revising the Training Package and finalizing the finished product

5. SEMESTER 5 IN THE PROGRAM

Following the design of the Training Package, the fifth and final semester of the program would have the students continue on in their project, gathering information they would need to develop their training into an online venue. The first part of the semester was spent to research, followed by the design of their training online, with the final task being a written case study over their process with the expectation that they would submit this as an article to a journal or as a paper to be presented at conference.

Research (PBL Inquiry):

Distance Learning Course (Instructional/Curriculum). Presented in the form of a literature review, this research focuses more on the learners, their abilities, assessment/evaluation, the tech tools (apps, videos, etc.) to use to address the learner's needs, ethics involved in online learning venues, and instructional online learning theories.

Management Application Analysis Course (Infrastructure/Software). This is a study of the hardware/infrastructure used to be able to present the learning materials. Beginning with a Literature Review to discover what criteria would be best to review the Learning Management Systems (LMS's), the literature review is directed to the three areas of Course Building Functions, LMS Server Functions, and LMS Training and Service.

Article Submission (PBL Authentic Public Audience). Over the two semesters, students researched, interviewed, analyzed, planned, developed, reviewed, revised, and implemented their training packages. Now, they are given the opportunity to "tell your story". Conducting successful training with technology and the implementation of technology continues to be an enigma, in some cases. Some is deemed successful, some is not. Some instructors take what they've learned from their training and implement it for their learners. Some simply go through the training as it's presented, but leave with nothing they want or intend to pass along to their learners. Perhaps this conundrum is exacerbated by the mere difference in philosophies of what technology is, does, and its intended purpose; along with what goals, if any, it helps us achieve.

During the last two semesters, via the intentional design of the curriculum in the MIST program, students were guided through the steps necessary to plan, prepare, and conduct a training session that is meaningful for their chosen audience. The assignment of the Publishable Paper provides the vehicle for them to share with others the process of developing a training package worthy of success. It also serves as their reflection over the process and allows them to consider how to improve upon it next time. With this paper, they have the opportunity to help others understand the process of achieving more successful implementation of technologies into their instruction.

The article brings together the various elements as broken down above:

a. Research conducted to identify the organization's Technology Goals
b. Conducting the Technology Analysis
c. Analyzing the Current Status of the Organization and its learners and its progress toward the achievement of its technology goals
d. Developing and Designing Objectives for the Organization's Training
e. Development of your Assessment Instruments
f. Researching and developing the Funding and Management strategy for the Training
g. Developing the Training Package itself
h. Evaluating with Training Package
i. Revising the Training Package and finalizing the finished product
j. Conducting the Literature Review and LMS Review and how that led you to decide on what you would do for your online training package
k. How did you implement your training? What problems occurred? Did you achieve your training goals and objectives?
l. How would you change your online training to make it better next time?
m. After writing about all of the above, you will decide how you will share your experiences with the rest of the world (PBL: Voice and Choice). This should be in the form of a journal article, case study, conference proceedings, etc.

The listed requirements above align directly with what students have done throughout the past two semesters. Therefore, they've lived it, reflected on it, documented the process at various junctures; and now had the opportunity of bringing all of this process together in one written paper. Reviewing their writings, reflections, findings, etc., melding them into their own stories, they could share how they developed a successful training package.

6. FINDINGS

Developing an integrated curriculum between two courses in higher education are challenging at best. While it appears that the divide between departments and colleges might make the task impossible, the common bond of the unique program that brings some faculty from the two departments together certainly helps alleviate the challenges. In addition, the working relationship of having taught in unison over the years helped to create a sort of philosophical foundation that facilitates the process.

We, as our students, never stop learning. This challenge of merging these two courses for these two semesters certainly underscored that fact. Here are some of the lessons we've learned so far in the process:

Communicate,Communicate,Communicate: Communication between instructors to ensure that we are constantly checking and rechecking each other's expectations for our students while they address objectives of both courses.

Communication between instructors and students (PBL: Communication) to clarify expectations and provide explanations. The consistency with which we answer our students, the way we copy each other in e-mails, and our being open to conversation among the two courses also models collaboration for our students.

Communication among students (PBL: Communication) is critical as they work in teams to support to each other via peer reviews (which prompts revisions) (PBL Reflections & Revisions), academic discussions about current research and what is still necessary to be learned (PBL Need for Know's), and learn to work collaboratively (PBL: Collaboration) on some of the selected assignments.

Communication about the course expectations need to be written, clear instructions. In addition, insert videos, online office hours, and strive for quick e-mail responses to ensure students do not have lingering questions or feel lost in cyberspace.

Design Good Assessments from the Very Beginning: Design good rubrics that are aligned with the standards/objectives. This process continues to remind students of "why are we doing this" (because there are standards we must address) as well as continue to communicate your expectations for their level of performance in presenting evidence of mastery of the objectives for the courses.

Keep it Simple! In an online course, don't confuse your students with how the assignments, project, and information is presented visually within your learning management system. You must guide them through the process even though they have many junctures for voice and choice along the way. Project based learning is a very cyclical process; it is not a checklist of things where you check them off and forget them. Everything should have a purpose in the complete project and "count" for something. All should be connected. In a true project based learning course, you have no room or time for extraneous, disconnected assignments.

But, at the same time, there is a "common path" (the center line) that moves students forward. Present online materials that maintain the "common path" that guides their journey. This can be accomplished by presenting to them an order of expectations (assignments) that they will be doing as they continue on their project journey. Most commonly known as a linear presentation, let that be the center line, while your various assignments allow them to "circle back" a few steps as needed as they implement self-assessments and peer reviews, and find it necessary to re-think decisions they find were not the best. This is part of the process of giving them the autonomy to make those changes for a better end product while keeping the center line in focus.

7. CONCLUSIONS

Sharing the goal to create a curriculum with better learning opportunities for students, but faced with the challenge of being two separate departments in two separate colleges; faculty in the Master's in Instructional Technology Program at Sam Houston State University chose to seat the collaborative instruction within the framework of project-based learning. Having used at least some of the elements of PBL in our individual courses in prior semesters, we had seen the positive impact the process of PBL had on our students as they found a real purpose to their efforts and how it gave them the opportunity to act more autonomously as they demonstrated mastery of the standards.

Over the course of two semesters, students followed a single path for their learning journey while mastering objectives for both courses. The process began with a chart, serving as a graphic, of the overall objectives of the two semesters and the designation of which objectives belong to each course. Following this, the objectives from each course were aligned with the rubrics in the respective courses. At the foundation of the two semesters was inquiry, as students developed their authentic products.

Discoveries during this process were seated mostly in the challenges of integrating the two courses into the one journey for the students. The charts, models, and rubrics were the foundation for the plan; but we continued to find that communication between ourselves, with students, and among students was paramount to clearly communicating expectations for the two courses, especially in the online environment. As we moved through the process, we found that the simpler the written and oral explanations to the students in these online courses; the better was the quality of their products.

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Appendix

Learning Objectives	CIED Distance Learning	CIED 5369 Resources/ Strategies	CSTE Management Application Analysis	CSTE 5338 Resources/ Strategies
○ Identify the areas of organization's profile in Technology, Funding, and Management ○ Identify the related legislated requirements and regulations ○ Research and Summarize the perceived technological needs from the organization/ management, teachers/trainers, students/learners, parents	o Identify the organization profile in Technology **(Instructional/Curriculum)** ○ Identify the organization profile in Funding and Management **(Instructional/Curriculum)** o Identify the related legislated requirements and regulations (for **Instructional/Curriculum**) ○ Research and Summarize the perceived technological needs (for **Instructional/Curriculum)** from the: a. administrators/management, b. teachers/trainers, c. students/learners, d. parents/vendors (or other party who has a stake in the training)	*Vision/ Master Plan of Organization/ Written Policies *Identify Federal and State Technology Standards, Industry Standards & Expectations *Interviews/ Surveys	○ Identify the organization profile in Technology **(Infrastructure/ Hardware)** ○ Identify the organization profile in Funding and Management **(Infrastructure/Hardware)** ○ Identify the related legislated requirements and regulations (for **Infrastructure/Hardware**) ○ Research and Summarize the perceived technological needs (for **Infrastructure/Hardware)** ○ from the: a. administrators/management, b. teachers/trainers, c. students/learners, d. parents/vendors (or other party who has a stake in the training)	*Physical layout of technology infrastructures including computer systems and peripherals in laboratories, classrooms, and other instructional arrangements *Existing storage devices, network systems, software implemented *Observing the maintenance support system for installing, troubleshooting, managing, and maintain for LAN, WAN, and other educational systems

A Big Data Analytics Methodology Program in the Health Sector

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Abstract

The benefits of Big Data Analytics are cited frequently in the literature. However, the difficulties of implementing Big Data Analytics can limit the number of organizational projects. In this study, the authors evaluate business, procedural and technical factors in the implementation of Big Data Analytics, applying a methodology program. Focusing on organizations in the health sector, the authors learn that business and procedural factors are collectively more critical than factors of technology in managing Big Data Analytics projects that attempt to contribute discernable impact; and they further learn that managing for practical results than for strategy is more evident on the projects in the sector. The study will benefit educators in improving Big Data Analytics curricula with a methodology program and will benefit practitioners in the sector in initiating systems.

Keywords: analytics, big data, big data analytics, heath sector, methodology program

1. BACKGROUND

Big Data is commonly defined as "bigger and bigger and bigger" (Aiden, & Michel, 2013) agglomerates of data. Big Data is data from disparate external and internal multiple sources (Khawaja, 2014), not mere single sources. Big Data Analytics is defined as methods or practices for dissection of Big Data, in order to derive benefits (Beller, & Barnett, 2009). Because of the disparity and multiplicity of sources of Big Data Analytics, the discipline is challenging for business organizations in attempting to achieve benefits, such that Big Data Analytics may be helped by improved Business Intelligence practices. Business organizations, especially in the health sector, are however initiating Big Data Analytics projects (Mamonov, Misra, & Jain, 2014), as the field is cited as a focus of high priority (CIO, 2014, & DMG Consulting Group, 2015).

The benefits of Big Data Analytics are in the conversion of the applicable data into better information for decision-making (Kontzer, 2015). Managers may gain holistic information contributing to improved customer experiences and new opportunities, in products and services that increase organizational profitability (Goldberg, 2014, & Pellet, 2015). Managers in business organizations may gain meaningfully more improved internal processes that further increase profitability and satisfaction (Overby, 2014). Managers in the health care sector may be helped by methods of Big Data Analytics mining (Eddy, 2015b, & Koh, & Tan, 2014), in optimization of processes and in relationship strategies. Literature (Accenture, 2014) indicates the highest managerial satisfaction from implemented Big Data Analytics projects of sector transformations.

Estimates from consulting firms of the Analytics and Business Intelligence field are $14.4 billion of software installations, of which Big Data Analytics is the fastest in investment by business organizations (Gartner Group, 2014). Field investments by the organizations are increasing at an annual growth of 8.5% that is higher than the growth in investments in other technologies (Kiron, Prentice, & Ferguson, 2014), as the organizations highlight the benefits of Big Data Analytics innovation in their sectors. The health sector is increasing investments in Big Data Analytics at $381 million of its technologies in 2014 (Ghosh, 2014), as organizations in the sector indicate the benefits of clinical, medicinal and operational performance from Big Data Analytics projects, justifying Analytics systems as a high priority in 2015. The information on investments in Big Data Analytics is indicating that organizations are beginning to leverage this technology. Though literature (Forrester Group, 2014) is indicating Big Data Analytics as essentially the highest priority in technology in 2015, the methods followed by organizations for fruitful implementation of this technology are elusive in the research.

2. INTRODUCTION TO STUDY

Big Data Analytics is a challenging endeavor to manage in business organizations (Bell, 2015). The appreciation of data as an asset – capital - in a core culture of analytical data-driven organizations is a concern in the information management of Big Data Analytics projects (Kiron, Prentice, & Ferguson, 2014). The appreciation of collaboration on Big Data across departments of organizations is a concern in the absence of data governance on Analytics projects (Weiss, & Drewry, 2014). The complexity of consolidating diverse external and internal multiple Big Data sources for holistic insight on business opportunities by business staff skilled in Big Data Analytics is a concern on systems (Baldwin, 2014). The difficulties of having skilled Analytics technical staff in integrating new platforms of product resilient software (Gupta, 2014) are problems that may preclude the benefits of Big Data Analytics systems. The mandate of executive management for Big Data Analytics is enabled only if scalable technology managed by skilled Big Data technologists is evident in the organizations (Kiron, Prentice, & Ferguson, 2014). The privacy and security of Big Data systems is a major problem (Barocas, & Nissenbaum, 2014), especially in the health sector (Ghosh, 2015b). Literature (McCafferty, 2014) indicates that most organizations fail to maximize meaningful organizational results from the technology. Big Data Analytics is a daunting initiative to organizations attempting to expand the potential of the technology without the maturity of a methodology or a strategy.

In the study, the authors consider a methodology for business organizations initiating Big Data Analytics projects. Managers may not be cognizant collectively of business, procedural and technical dimensions of data and organizational processes (Jagadish, 2014) that may have to be modified on Big Data Analytics projects (Kiron, Prentice, & Ferguson, 2014), in order to maximize the potential of the technology. Technical staff may be cognizant of existing resources and software technologies for localized Analytics or Business Intelligence projects but not of larger network resources and storage technologies needed on Big Data Analytics systems (Klaus, 2014, Singh, Mathur, & Srujana, 2014, and Stonebraker, 2015). The benefits of a disciplined methodology are in comfortably enabling and guiding business and technical staff in incrementally initiating organizational processes and technologies of Big Data Analytics in a Big Data Analytics strategy. The methodology is not a functional project methodology but a global methodology program recognizing the massive scope of Big Data Analytics.

The Big Data Analytics methodology program of this study is a control plan that may be applied to Big Data Analytics projects by business organizations. The features of the methodology consist of Big Data governance (May, 2014), in order to ensure that information is derived optimally for organizational insight. The methodology contains Big Data infrastructure management (Sonderegger, 2014), in order to ensure that Analytics systems interoperate optimally with resilient and scalable technology. The methodology further includes responsibilities and roles of business staff engaging data scientist and skilled technical staff (Dietrich, 2014), in order to ensure that the focus of the Big Data Analytics projects is on business objectives decided by the business management staff. Inclusion of responsibilities and roles and internal standards in the methodology insures that scientist and technical staff are not isolated from business stakeholder staff. The methodology program is a model for best practices in the evolution of Big Data Analytics projects in organizations, such as in the health sector (Ghosh, 2015a). The research is limited on models of best practices from a methodology program on Big Data Analytics projects (Moore, 2014). In short, the methodology program of the study benefits organizations with best practices that may be a foundation for a fruitful Big Data Analytics strategy.

3. FOCUS OF STUDY

The essence of the study is to evaluate business, procedural and technical factors of a Big Data Analytics methodology program in the implementation of organizational projects. The factors are formulated by the authors from leading practitioner researchers, given limited scholarly sources. The focus of the study is on factor impacts on project success.

The business factors on the implementation of Big Data Analytics projects are below:

- *Agility and Competitiveness* (Phillipps, 2012), Extent to which improved agility and competitiveness contributed to project success;
- *Analytical Intuition* (Kiron, Prentice, & Ferguson, 2014), Extent to which methods for integrating Big Data Analytics and executive intuition for management contributed to success;
- *Analytical Maturity of Organization* (Nott, 2014, Phillipps, 2012, & Pramanick, 2013), Extent to which maturity of the organization in fundamental Analytics methods contributed to success;
- *Analytical Process* (McGuire, 2013), Extent to which organizational processes for integrating Big Data Analytics contributed to success;
- *Big Data Strategy* (Iodine, 2014, McGuire, 2013, & Phillipps, 2012), Extent to which Big Data organizational strategy, having a clearly defined Big Data Analytics subset contributed to success;
- *Budgeting for Big Data Analytics* (Columbus, 2014), Extent to which funding for Big Data Analytics contributed to success;
- *Center of Excellence* (Phillipps, 2012, & Pramanick, 2013), Extent to which growth of Big Data Analytics with Big Data Analytics best practices, coordinated by a central department of Analytics staff contributed to success;
- *Change Management – Business* (Bartik, 2014, Davenport, 2014, Kiron, Prentice, & Ferguson, 2014, & Nott, 2013), Extent to which changes in business departments of the organization in order to leverage Big Data Analytics contributed to success;
- *Collaboration in Organization* (Columbus, 2014, & Lipsey, 2013), Extent to which cooperation in diverse business and technical departments on Big Data Analytics projects contributed to success;
- *Control of Program* (Nott, 2013, & Pramanick, 2013), Extent to which control of Big Data Analytics by the business management staff, in close cooperation with the technology staff, contributed to success;
- *Data Integration* (Columbus, 2014, Lipsey, 2013, Nott, 2013, Phillipps, 2012, & Pramanick, 2013), Extent to which data considered as an asset, common to the organization for accessing and repurposing by the diverse business and technical staff, contributed to success;
- *Education and Training* (Kiron, Prentice, & Ferguson, 2014), Extent to which training of the business and technical staff in Big Data Analytics contributed to success;
- *Executive Management Support* (Kiron, Prentice, & Ferguson, 2014), Extent to which executive support of Big Data Analytics contributed to success;
- *Measurements of Program* (Lipsey, 2013, & Phillipps, 2012), Extent to which measurements of performance of the Big Data Analytics projects contributed to success;
- *Organizational Strategy (Idoine, 2014, Kiron, Prentice, & Ferguson, 2014, and Nott, 2014), Extent to which integration of Big Data Analytics with organizational strategy contributed to success; and*
- *Specification of Use Cases (Davenport, 2014), Extent to which use cases, including functional flows and requirements, contributed to success.*

The procedural factors on the projects are:

- *Best Practices (Davenport, 2014, Kiron, Prentice, & Ferguson, 2014, and Pramanick, 2013), Extent to which application of Big Data Analytics best practices from external research contributed to project success;*
- *Big Data Analytics Governance (Todd, 2010), Extent to which establishment of guidelines*

for Big Data Analytics initiatives contributed to success;

- *Curation of Data (Columbus, 2014, & Nott, 2013), Extent to which curation of Big Data for quality contributed to success;*
- *Data Governance (Nott, 2013, Nott, 2014, & Lipsey, 2013), Extent to which existing data management methods contributed to success;*
- *Internal Standards (Bleiberg, 2014), Extent to which governance internal processes contributed to success;*
- *Process Management (Lipsey, 2013, & Nott, 2013), Extent to which maintenance of processes in Big Data Analytics initiatives contributed to success;*
- *Program Management and Planning (Bleiberg, 2014, & Davenport, 2014), Extent to which a centralized management team, with iterative planning skills and with executive management support, contributed to success;*
- *Responsibilities and Roles (Idoine, 2014, Lipsey, 2013, & McGuire, 2013), Extent to which clearly defined roles of business and technical staff engaged on Big Data Analytics projects contributed to success;*
- *Risk Management (Weathington, 2014), Extent to which rigorous risk management processes for Big Data contributed to success;*
- *Selection of Product Software from Vendor(s) (Vance, 2014), Extent to which methodological processes for project selection(s) of software from vendor(s) contributed to success;*
- *Staffing (Columbus, 2014, Davenport, 2014, Lipsey, 2013, & Pramanick, 2013), Extent to which business and technical staff on Big Data Analytics projects contributed to success.*

The technical factors are:

- *Agility of Infrastructure (Phillipps, 2012), Extent to which infrastructure responsiveness with Big Data contributed to project success;*
- *Change Management – Technology (George, 2014, & Lipsey, 2013), Extent to which infrastructure operational processes for leveraging Big Data Analytics contributed to success;*
- *Cloud Methods (Pramanick, 2013), Extent to which cloud provider technology contributed to success;*
- *Data Architecture (Nott, 2014), Extent to which new Big Data organizational processes rules contributed to success;*
- *Data Ethics and Privacy (Nott, 2013, & Phillipps, 2012), Extent to which initiation of privacy and regulatory requirements contributed to success;*
- *Data Security (Columbus, 2014, & Lipsey, 2013), Extent to which initiation of processes for rigorous security of Big Data contributed to success;*
- *Data Services (Lipsey, 2013), Extent to which centralized managed Big Data services contributed to success;*
- *Entitlement Management (Bartik, 2014), Extent to which management of Big Data access privileges contributed to success;*
- *Infrastructure of Technology (Columbus, 2014, & Nott, 2013), Extent to which initiation of a scalable technology contributed to success;*
- *Internal Software (Vance, 2014), Extent to which internal organizational Analytics software contributed to success;*
- *Multiple Product Software Vendors (Columbus, 2014), Extent to which integration of external Big Data Analytics software from multiple vendors contributed to success;*
- *Product Software of Vendor (Vance, 2014), Extent to which integration of external Big Data Analytics software from a single vendor contributed to success;*
- *Usability of Technology (Lipsey, 2013), Extent to which usability of external software and internal organizational software contributed to success; and*
- *Visualization Tools (Phillipps, 2012), Extent to which Big Data visualization tools contributed to project success.*

Literature (IBM, 2014, & Informs, 2014) indicates that most organizations lack a methodology program to evaluate Big Data Analytics maturity, notably in the health sector, which is highly motivated to initiate investment in the technology (Eddy, 2015a). The study will benefit educators (Analytics, 2014) in informing information systems students on organizational practices and will help practitioners (Davis, 2014) in learning an integrated methodology program for strategy and success.

4. RESEARCH METHODOLOGY

The research methodology of the study consisted of a case study of 5 organizations in the health sector, chosen from Big Data Analytics pioneers headquartered in New York City and highlighted in leading practitioner publications in the July – December 2014 period. The health sector was chosen by the authors as the sector correlated to the first sector of study in their concentration curriculum for Big Data Analytics at the Seidenberg School of Computer Science and Information Systems of Pace University (Molluzzo & Lawler, 2015) – energy, entertainment, financial and retailing sectors will be studied in the 2016 – 2019 period.

The projects in the 5 organizations in the health sector were evaluated by the first and third authors from a checklist definition instrument of survey of the 41 aforementioned Big Data Analytics factors of the methodology program, in the January – April 2015 period. The factors were evaluated on evidence of contribution to Big Data Analytics project success, on a 6-point Likert-like rating scale:

- *(5) Very High in Contribution to Project Success;*
- *(4) High in Contribution;*
- *(3) Intermediate in Contribution;*
- *(2) Low in Contribution;*
- *(1) Very Low in Contribution; and*
- *(0) No Contribution to Success.*

The evaluations were founded on in-depth observation of mid-management project members in the organizations, averaging 3 – 5 personnel in the organizations; informed perceptions of observation rationale by the third author, a practitioner of 35+ years; and research reviews of secondary studies by the first author.

The checklist instrument of the study was checked in the context of construct, content and face validity and content validity, measured in sample validity, by the second author. The methodology was consistent in creditability and proven reliability with earlier studies by the authors on cloud computing (Lawler, Howell-Barber, & Joseph, 2014) and service-oriented architecture (SOA) technology (Lawler & Howell-Barber, 2008). The data from the evaluations was interpreted in the MATLAB 7.10.0 Statistics Toolbox (McClave & Sincich, 2006) by the second author, in the May – June 2015 period, for the following section and the tables in the Appendix.

5. ANALYSIS OF DATA

Detailed Analysis of Organizations* in Health Sector

Organization 1: Health Insurance Provider
Project: Medical Analytics System

Organization 1 is (in revenue) a large-sized national organization that focused on a medical predictive analytics project, in order to gain a competitive edge in the sector. The goal of the system was to integrate external and internal data of employees of customer organizations that could be helped by interventions in lifestyles to lessen diseases. The system helped the employees in disease management and the member organizations in cost management, in predicting and reducing health risks.

Organization 1 benefited by a *Center of Excellence* (5.00) of Big Data business and technical staff that managed the project with *Cloud Methods* (5.00) and the *Infrastructure* (5.00) of proprietary *Product Software from a Vendor* (5.00). Factors of *Process Management* (4.00) and *Program Management and Planning* (4.00) were evident highly in the *Center of Excellence* (5.00), with data flows of functions and requirements in *Specifications of Use Cases* (5.00). *Data Ethics and Privacy* (4.00) and *Security* (4.00) were evident highly in the process. The *Center of Excellence* (5.00) focused however on incrementally interpolating Big Data on discrete diseases without fully integrating the business departments of Organization 1 in *Control* of *Program* (1.00) and *Data Governance* (2.00), or in a *Big Data* (1.00) or *Organizational* (2.00) *Strategy*. The project was managed with the factors of *Budgeting* (5.00) and *Executive Support* (3.00), but without *Internal Standards* (0.00) or *Measurements of Program* (1.00).

Organization 1 is an example of an organization gaining leverage with Big Data Analytics, but not optimizing the project for a more fruitful governance and strategy.

Organization 2: Health Monitoring Provider
Project: Medical Monitoring System

Organization 2 is a large-sized national organization that focused on a predictive surveillance system, in order to improve knowledge of health threats and trends. The goal of the system was to integrate external and internal data of events in hospitals that could be helpful and insightful to scientists in investigating and responding sooner to threats. The system helped the scientists in propagating standards in hospital systems, in order to be responsive to trends.

Organization 2 benefited by a higher *Analytical Process* (5.00) than Organization 1, as *Big Data Analytics Governance* (4.00) and *Data Governance* (4.00) were evident on the Organization 2 project. Factors of *Internal Standards* (5.00) and *Measurements of Program* (4.00) were evident highly in the organizational Big Data Analytics project. Organization 2 focused on the external and internal data on the hospitals, through *Internal Software* (3.00) and through predictive *Product Software of Vendor* (2.00), but without historical *Analytical Intuition* (1.00) and without requiring *Cloud Methods* (0.00). *Data Ethics and Privacy* (4.00) and *Security* (5.00) were prudently recognized by the scientists. The project was impressively managed with a *Big Data Strategy* (5.00).

Organization 2 is an example of an organization improving its Big Data Analytics with governance methods and with initiation of strategy with mostly internal technologies.

Organization 3: Health Mail Order Pharmacy Provider
Project: Medical Patient Prescription System

Organization 3 is a mid-sized regional organization that focused on a predictive proactive prescription system, in order to increase knowledge of patient prescriptions. The goal of the system was to integrate external and internal data on patients that could be helpful to the patients and to their physicians in prescribing the taking or non-taking of the prescriptions. The system helped the patients in management of prescriptions and the member physicians in cost and health management, in reducing preventable risks.

Organization 3 distinguished its Big Data Analytics initiative by *Analytical Intuition* (5.00), *Analytical Process* (5.00) and *Analytical Maturity of Organization* (5.00). Procedural factors of *Process Management* (4.00), *Program Management and Planning* (4.00) and *Risk Management* (5.00) were evident highly on the project. The project included a *Center of Excellence* (5.00) of skilled business and technical staff, integrating only its *Internal Software* (5.00) technologies and involving the business departments of the organization in *Collaboration in Organization* (4.00), with *Executive Support* (5.00). *Ethics and Privacy* (4.00) and *Security* (5.00) were recognized in the initiative in Organization 3, as in Organizations 2 and 1. Though the maturity of the organization in analytical processes and technologies was more notable on the project, the maturity was less notable in *Big Data Analytics Governance* (3.00), *Data Governance* (3.00), *Internal Standards* (3.00) and *Measurement of Program* (1.00), and in *Big Data* (2.00) and *Organizational* (3.00) *Strategy*.

Organization 3 is an example of an organization in the health sector increasing its initiative in Big Data projects, but not positioning its processes and technologies for the rigor of a Big Data Analytics strategy.

Organization 4: Hospital Organization Provider
Project: Medical Residential System

Organization 4 is a large-sized national organization that initiated a predictive proactive residential system, in order to integrate Big Data information from localized device monitors of patients. The objective of this system was to integrate this external information into a clinical data repository that could be helpful in a holistic interpretation of patient progress. The system helped hospital physicians and staff, in more meaningful profiling of patients from remote sites.

This organization enabled its Big Data initiative by a *Center of Excellence* (4.00) of internal data scientist staff that managed the project with non-proprietary Analytics *Software from a Vendor* (5.00). Inclusion of *Internal Software* (2.00) and internal non-scientist technical staff not in the *Center of Excellence* (4.00) were limited on the project. The project was limited in *Big Data Analytics Governance* (3.00) and *Data Governance* (3.00), and in *Internal Standards* (3.00) and *Measurement of Program* (1.00) notably, though the project was managed from *Big Data Strategy* (3.00) and *Organizational Strategy* (4.00) of integrating the external information on the monitors of the patients into the internal repository system, with precise *Specification of Use Cases* (5.00). This organization was sensitive to *Privacy* (4.00) and *Security* (4.00), as in Organizations 3, 2 and 1. This project was managed with the concurrence of *Executive Support* (4.00) without reservation.

Organization 4 is an illustration of a provider in the sector initiating a meaningful Big Data Analytics project without re-engineering internal processes.

Organization 5: Hospital Organization Provider
Project: Medical Treatment System

This organization is a small-sized regional organization that initiated a specialized treatment system, in order to interpolate Big Data findings from national studies. The objective of this system was to interpolate this external information with internal information on patients that could be helpful to hospital physicians in offering options of personalized treatments. The system helped the patients and the physicians in scenarios of specialized treatments.

This organizational project was managed by *Center of Excellence* (4.00) data scientist staff with limited organizational technologists. The project was however impressively managed with more *Big Data Analytics Governance* (4.00), *Data Governance* (5.00), *Internal Standards* (5.00), *Process Management* (4.00) and *Program Management and Planning* (4.00) overall, than on the previous projects. The *Product Software of* the *Vendor* (5.00) was the project technology, without *Internal Software* (0.00) technologies. The scientist staff was sensitive to *Privacy* (4.00) and *Security* (5.00), as in the previous projects. The staff was not overtly sensitive to *Big Data Strategy* (2.00) or *Organizational Strategy* (2.00), nor to *Measurement of the Program* (2.00), with senior management in *Executive Support* (5.00) supporting minimal strategic techniques.

This organization is an illustration of a provider in the sector proceeding on a meaningful but specific Big Data Analytics system without further strategic techniques.

*Organizations are not identified in the Analysis due to competitive imperatives in the sector.

Summary Analysis of Organizations in Health Sector

The analysis of the data findings from the organizations in the section is highlighting the business factors (3.09 [summary in Table 1 in the Appendix]) as important to Big Data Analytics success. The *Center of Excellence* in Big Data Analytics (4.20 [detail in Table 2]) having largely scientist staff, the funding through *Budgeting* of the projects (4.00) and the *Management Support* (4.40) were more important in most of the organizations. The factors of *Big Data Strategy* (2.60), *Change Management* (1.40), *Control of Program* (2.00), *Measurements of Program* (1.80), and *Organizational Strategy* (2.60) were less important on most of the projects, as the organizations were focused more on the nuances of the project results, not on re-engineering strategy.

The analysis of the findings is indicating the procedural factors (3.80) were important to success, but more than the business factors (3.09). The procedural factors of *Process Management* (4.00), *Program Management and Planning* (3.40) and *Risk Management* (5.00) were important on most of the projects, but *Big Data Analytics Governance* (3.20), *Data Governance* (3.40) and *Internal Standards* (3.20) were less important on most of the projects to Big Data Analytics success, as the organizations were focused on practical results from systems, not procedural techniques.

The technical factors (3.44) were also important to success, but less than the procedural (3.80) and more than the business (3.09) factors. The technical factors of a single *Product Software of a Vendor* (3.60), interoperating in the *Agility of Infrastructure* (4.60) with the existing organizational *Infrastructure Technology* (4.20) were more important than *Cloud Methods* (1.20), *Internal Software* (2.00) technologies and *Multiple Product Software Vendors* (1.80), as the organizations were focused more on product software technologies of so-called Big Data Analytics vendors. The factors of *Data Ethics and Privacy* (4.00) and *Data Security* (4.60) were important on all of the projects, as the organizations were notably sensitive to Big Data Analytics of health information.

Essentially, the factors of the Big Data Analytics methodology program were found at different ratings to be facilitating the organizational projects in the sector more in results than in strategies.
(Correlations between pairs of the organizations are in Table 3, and frequency of ratings across the factors are in Table 4, of the Appendix.)

6. IMPLICATIONS OF STUDY

The evaluations of the organizations in the study found that a Center of Excellence in Big Data Analytics was critical on the projects in the health sector. The center of data scientists drove the Predictive Analytics projects with their skills. Even though the center might have cooperated more efficiently with the internal organizational staff (Harris, & Mehrotra, 2014), if not integrated more of its skills with this staff, the data scientists enabled insightful integration of the Big Data for management teams. The center, as a dedicated department that was business driven, dissuaded ad hoc Analytics departments (Greengard, 2015) in the organizations. The importance of a distinct department for Big Data Analytics is an immediate implication for the health sector.

The evaluations of the organizations found however that centralized Big Data governance of the projects was not considered as critical in the cultures of these pioneers as an established Center of Excellence. The governance of the projects was not customized for Big Data from the existing governance methods for mundane Data projects. Measurements of optimized performance of the projects were elusive in most of the organizations. The organizations might have further improved methods for ever-increasing needs for resiliency and scalability (CenturyLink, 2014) of the Big Data Analytics systems. The importance of a governance methodology model needed for Big Data Analytics projects is an implication for the health sector.

The evaluations in the study found that privacy and security were considered critical factors for management in the organizations. The organizations had new policies on the privacy of Big Data health information on patients, as security is crucial in the health sector (Shaw, 2014). The importance of privacy and security on Big Data Analytics systems is a further implication of the study.

The organizations were found to be gaining important insight from their Big Data Analytics projects. Still, though these organizations were leveraging the projects, mostly in patient services, for success, they were not maximizing methods or optimizing processes in a Big Data Analytics strategy. They were short of a Big Data Analytics strategy that might be incrementally positioning the potential of Big Data Analytics software technologies (Overby, 2014). This might not be negative in the health sector (Asay, 2014), as other sectors are indicated to be in preliminary stages with these technologies (Batra, 2015, & Major, 2014). The importance of a needed Big Data Analytics strategy, to optimize the potential of Big Data Analytics technologies, is an implication for the health sector.

Finally, the evaluations of the organizations in the study highlighted the need for Big Data Analytics health sector staff (Collett, 2014). Most of the organizational staff, apart from the data scientist staff, were without Big Data Analytics skills. Educational programs in schools of computer science and information systems might be improved with inter-disciplinary skills (Wegryn, 2014), so that graduate and undergraduate students might gradually have initial smarts as specialists in Big Data Analytics. Programs might be improved in internships with organizations (Fitzgerald, 2014), such that they might be initially prepared for projects in the sector. The importance of education and training in Big Data Analytics is the last implication for this sector.

7. LIMITATIONS AND OPPORTUNITIES IN RESEARCH

The findings from this study are from a limited number of organizations incrementally pioneering Big Data Analytics projects in the health sector. The leveraging of Big Data Analytics in the sector is inhibited by a limited maturity in methodology that does not maximize the technologies. The results of this study may not be generalized to the sector or other sectors without caution. The findings from the Big Data Analytics methodology program of this study furnish however a foundation for further research into the implementation of Big Data Analytics projects, as organizations pursue the technologies. This foundation will benefit educators in integrating best practices into information systems curricula and practitioners in the sector in pursuing success.

8. CONCLUSION

The authors conclude that the organizations in the health sector of this study are benefiting from Big Data Analytics projects.

Business factors, from an applied Big Data Analytics methodology program, were important in project success. Centers of Excellence in Big Data Analytics, as distinct entities in the organizations, were instrumental in the success.

Procedural factors of process management, program management and risk management were especially important, more than the business factors. Factors of Big Data governance and Data governance and internal standards were not important on the projects, as the organizations were focused on narrow results from systems, not procedural techniques.

Factors of technology were integral in project success, less pronounced than the procedural but more pronounced than the business factors of the Big Data Analytics methodology program, in the sector. Health information in the Big Data Analytics systems was managed with high privacy and security sensitivity.

The organizations proceeded on the projects short of Big Data Analytics strategies that would have incrementally optimized the power of the technologies. The organizations in the sector were also short of Big Data Analytics skills, but were substantially supported by the data scientist specialist staff in the Centers of Excellence, in the period of this study.

The results of this study will be helpful to instructors in schools of computer science and information systems and to practitioners in the health sector, and other organizational sectors, interested in searching for Big Data Analytics success techniques if not transformation.

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Editor's Note:

This paper was selected for inclusion in the journal as a EDSIGCon 2015 Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2015.

APPENDIX

Table 1: Summary Analysis of Big Data Analytics Factors in Organizations in Health Sector

Categorical Factors of Methodology	Means	Standard Deviations
Business Factors	3.09	1.37
Procedural Factors	3.80	1.06
Technical Factors	3.44	1.68

Legend: (5) Very High in Contribution to Big Data Analytics Project Success, (4) High in Contribution, (3) Intermediate in Contribution, (2) Low in Contribution, (1) Very Low in Contribution, and (0) No Contribution to Project Success

Table 2: Detailed Analysis of Big Data Analytics Factors in Organizations in Health Sector Organizations

Business Factors	Org 1 Means	Org 2 Means	Org 3 Means	Org 4 Means	Org 5 Means	Summary Means	Standard Deviations
Agility and Competitiveness	5.00	2.00	4.00	5.00	3.00	3.40	1.52
Analytical Intuition	1.00	1.00	5.00	3.00	3.00	2.60	1.67
Analytical Maturity of Organization	5.00	3.00	5.00	4.00	4.00	4.20	0.84
Analytical Process	3.00	5.00	5.00	3.00	4.00	4.00	1.00
Big Data Strategy	1.00	5.00	2.00	3.00	2.00	2.60	1.52
Budgeting for Big Data Analytics	5.00	3.00	4.00	4.00	4.00	4.00	0.71
Center of Excellence	5.00	3.00	5.00	4.00	4.00	4.20	0.84
Change Management	0.00	1.00	2.00	2.00	2.00	1.40	0.89
Collaboration in Organization	3.00	1.00	4.00	3.00	3.00	2.80	1.10
Control of Program	1.00	2.00	2.00	2.00	3.00	2.00	0.71
Data Integration	2.00	3.00	3.00	2.00	5.00	3.00	1.22
Education and Training	1.00	4.00	3.00	3.00	3.00	2.80	1.10
Executive Management Support	3.00	5.00	5.00	4.00	5.00	4.40	0.89
Measurements of Program	1.00	4.00	1.00	1.00	2.00	1.80	1.30
Organizational Strategy	2.00	2.00	3.00	4.00	2.00	2.60	0.89
Specification of Use Cases	5.00	4.00	2.00	5.00	2.00	3.60	1.52

Procedural Factors	Org 1 Means	Org 2 Means	Org 3 Means	Org 4 Means	Org 5 Means	Summary Means	Standard Deviations
Best Practices	4.00	4.00	3.00	3.00	5.00	3.80	0.84
Big Data Analytics Governance	2.00	4.00	3.00	3.00	4.00	3.20	0.84
Curation of Data	4.00	5.00	4.00	4.00	5.00	4.40	0.55
Data Governance	2.00	4.00	3.00	3.00	5.00	3.40	1.14
Internal Standards	0.00	5.00	3.00	3.00	5.00	3.20	2.05
Process Management	4.00	4.00	4.00	4.00	4.00	4.00	0.00
Program Management and Planning	4.00	2.00	4.00	3.00	4.00	3.40	0.89
Responsibilities and Roles	5.00	2.00	4.00	3.00	5.00	3.80	1.30
Risk Management	5.00	5.00	5.00	5.00	5.00	5.00	0.00
Selection of Product Software from Vendor(s)	5.00	3.00	3.00	3.00	4.00	3.60	0.89
Staffing	5.00	3.00	4.00	3.00	5.00	4.00	1.00

Technical Factors	Org 1 Means	Org 2 Means	Org 3 Means	Org 4 Means	Org 5 Means	Summary Means	Standard Deviations
Agility of Infrastructure	5.00	4.00	4.00	5.00	5.00	4.60	0.55
Change Management	4.00	4.00	4.00	4.00	5.00	4.20	0.45
Cloud Methods	5.00	0.00	0.00	1.00	0.00	1.20	2.17
Data Architecture	1.00	4.00	2.00	4.00	2.00	2.60	1.34
Data Ethics and Privacy	4.00	4.00	4.00	4.00	4.00	4.00	0.00
Data Security	4.00	5.00	5.00	4.00	5.00	4.60	0.55
Data Services	0.00	3.00	1.00	2.00	5.00	2.20	1.92
Entitlement Management	5.00	5.00	4.00	4.00	5.00	4.60	0.55
Infrastructure of Technology	5.00	3.00	3.00	5.00	5.00	4.20	1.10
Internal Software	0.00	3.00	5.00	2.00	0.00	2.00	2.12
Multiple Product Software Vendors	0.00	2.00	3.00	4.00	0.00	1.80	1.79
Product Software of Vendor	5.00	2.00	1.00	5.00	5.00	3.60	1.95
Usability of Technology	3.00	4.00	5.00	4.00	5.00	4.20	0.84
Visualization Tools	5.00	4.00	4.00	4.00	5.00	4.40	0.55

Legend: Refer to Legend in Table 1.

Table 3: Correlations between Pairs of Big Data Analytics Organizations in Health Sector Study

	Organization 1	Organization 2	Organization 3	Organization 4
Organization 2	-0.0122			
Organization 3	0.1905	0.2307		
Organization 4	(0.4956)*	0.2104	0.2371	
Organization 5	(0.3257)**	(0.3535)*	(0.2753)**	0.2471

*Correlation is significant at the 0.01 level (2-tailed).
**Correlation is significant at the 0.05 level (2-tailed).
[Kendall Tau Correlation Coefficient]

Table 4: Frequency of Ratings across Big Data Analytics Factors in Health Sector Study

	Organization 1	Organization 2	Organization 3	Organization 4	Organization 5
Ratings					
0	12.2	2.4	2.4	0.0	7.3
1 – Very Low	14.6	7.3	7.3	4.9	0.0
2 – Low	9.8	17.1	14.6	12.2	14.6
3 – Intermediate	9.8	22.0	24.4	31.7	12.2
4 – High	17.1	31.7	29.3	36.6	22.0
5 – Very High	36.6	19.5	22.0	14.6	43.9
in Significance					

Legend: Refer to Legend in Table 1

Engaging Students as Co-Lecturers in Information Systems and Technology Courses

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Abstract

Engaging students in the learning process is critical to their learning experience. One common practice is to have student do the work and report it back in classroom as presentations. However, many of these presentations are solely presented by students and are crowded into specific presentation class sessions. This is suboptimal in achieving a teaching (learning) environment with balanced information exchange. This paper presents a collaborative lecturing methodology, which engages students in the complete process of learning design, topic research, and collaborative lecturing in classrooms. Key activities and features of the method are presented in a four-stage life cycle. The method has been employed by the author in multiple IT and IS courses of different subjects and levels. Past experiences and lessons learned will be discussed.

Keywords: information technology education, collaborative lecture, active learning, instructional design, student presentation

1. INTRODUCTION

Engaging students actively in the teaching and learning process has been proved to be an effective method in classroom (Prince, 2004; Michael, 2006). Of many current practices, student presentations are widely used as part of the classroom activities. For example, presentations are commonly planned as a concluding part of a topic research type assignment or project. Driven by the final oral presentation, students are required to do the work themselves in the preparation process and therefore learn in an active way.

Student presentations are organized in various formats. Some common practices and features of traditional student presentations are:

- Dedicated presentation sessions: they are usually held at the end of the semester or in a dedicated presentation period.
- Student led: these presentations are prepared and delivered by students solely. The instructor has little involvement and control of the presentation content during the presentation time.
- Limited and short time period: presentations are limited to a certain time period, which may be actively enforced.
- Performance focused evaluation: presentations are evaluated with a focus on in-classroom presentation performance.

The traditional study-and-present approach has varied learning effectiveness, much dependent on student capabilities. It is a good way to evaluate student learning results and presentation skills, but it is rather weak in terms of building classroom learning environments and contributing to the overall learning experience. A number of limitations are:

- Instructors generally do not know the presentation content until the actual presentation. Instructor-student interaction is poor in the process.
- Traditional report style presentations are difficult to foster a teaching (learning) environment with balanced information exchange. Presentations are often presenter-centered and lack of interaction. Other students are not sufficiently engaged in learning from their peers during presentations. "Too quiet" is often the issue in classroom.
- Students have various presentation skills, and the quality of presentation content also varies. Common pitfalls in presentation include reading slides, lack of interaction, or talking irrelevancy. All these factors create problems to student engagement and classroom learning.

Clearly the traditional presentation is more of an assessment tool rather than a facilitating tool that contributes to the classroom learning environment. To address this problem, a unique collaborative lecturing (co-lecturing) approach was introduced to utilize student presentations more effectively as an integral part of classroom learning. In the following sections, we will first briefly survey the theoretical background for the proposed pedagogical method, and then specify the methodology with details, followed by some initial student feedback. Last, we will conclude the paper with some discussions of key practices and lessons learned.

2. THEORECTICAL BACKGROUND

The co-lecturing approach lies on the theoretical basis of active learning, and is built on related practices of collaborative learning, peer learning, learning by teaching, and collaborative teaching. Although the definitions of these concepts are very similar and are closely related, there are some subtle differences and variations. The following sections briefly introduce and discuss these concepts and related practices.

2.1. Active Learning

Active learning refers to a general type of learning methods that focus on active participation of learners. One of the commonly accepted definitions come from Bonwell and Eison (1991) who suggested that students must engage in higher-order thinking tasks such as analysis, synthesis, and evaluation in order to be actively involved. More specifically, Bonwell and Eison (1991, p19) defined active learning as "anything that involves students in doing things and thinking about the things they are doing." Active learning practices favor student participation and engagement in the learning process and encourage learning from students' own efforts. Common practices include active writing, classroom discussion, problem solving, case study, students teaching, etc. (Halley, Heiserman, Felix, & Eshleman, 2013). Over the past two decades or so, active learning has grown increasingly popular and has drawn considerable amount of interest among educators (Faust & Paulson, 1998; Prince, 2004). It has been widely accepted in higher education as one of the effective instructional methods. Numerous research studies have supported the benefits of active learning for adult learners (Bonwell & Eison, 1991; Prince, 2004; Michael, 2006).

2.2. Collaborative Learning

Collaborative or cooperative learning involves students working in groups, or a joint effort of students and teachers (Smith & MacGregor, 1992). It is considered as one of the effective strategies in promoting active learning (Bonwell & Eison, 1991). Collaborative learning is centered on students' exploration or application of knowledge, and, in addition, emphasizes interaction with others and knowledge sharing (Du & Wagner, 2005). A broad range of research studies have shown that collaborative or cooperative learning enhances student achievement, attitude, retention, and inter-personal skills (Johnson, Johnson, & Smith, 1998; Springer, Stanne, & Donovan, 1999; Prince, 2004). Common practices include student teamwork in paper writing, presentation, and solution development projects.

2.3. Peer Learning/Learning by Teaching

Peer learning refers to the acquisition of knowledge and skill through active helping and supporting among peers (Topping, 2005). Students learn with and from each other without any implied authority (Boud, 2001). Particularly for adult students, learning from peers can best capitalize their experiences and knowledge. Adult students can serve as resources to the instructor and fellow learners. Instructors may use open-ended discussions to draw out students' knowledge and experiences (Boud & Middleton, 2003).

Learning by teaching or peer tutoring is often characterized as one sub-type of peer learning. Despite its many similarities with the general concept of peer learning, peer tutoring is more specifically focused on curriculum content and the role taking as tutor or tutee (Topping, 2005). Educators have noticed the positive effect of learning by teaching early on with research evidence showing high morale, good attendance, and general satisfactory to the school environment among kindergarten children (Frager & Stern, 1970). Other researchers also noticed that peer tutoring not only has effective benefits in terms of academic achievement, but also has affective benefits such as enhanced self-esteem (Cohen, Kulik, & Kulik, 1982; Lublin, 1990; Podl & Metzger, 1994; Tsui, 2010). Learning by teaching or peer tutoring can occur either in informal settings such as one-on-one discussion or in formal settings such as group projects that are explicitly scheduled into classes (Keppell, Au, Ma, & Chan, 2006).

2.4. Collaborative Teaching

Collaborative teaching or co-teaching is the practice to have more than one person acting in instructor's role. It has been reported by many instructors and researchers as an effective lecturing method (Dugan & Letterman, 2008; Robinson & Schaible, 1995; Zhou, Kim, & Kerekes, 2011). Co-teaching has various formats of how the teaching team is formed, including a team of faculty members, faculty and industry guest speakers, and faculty and students. The literature shows an emphasis on co-lecturing with multiple faculty members, and other formats are less reported. Dugan and Letterman (2008) compared three styles of collaborative faculty teaching and reported a preference for two faculty member teaching together. Tenenberg (2010) described an Industry Fellows model in which an industry professional joins the classroom on a regular basis as a co-lecturer. Sikosek (2009) reported student self-evaluation of their co-lecture activities in chemistry classes, and students praised their co-lecturer role as having an opportunity for guided and active study of course topics. The study, however, did not reveal the details of how these co-lectures are designed and conducted in the classroom.

3. THE INSTRUCTOR/STUDENT CO-LECTURING APPROACH

The proposed co-lecturing method emphasizes a learning-by-teaching approach but with close collaboration between instructors and students throughout the whole process, including the in-classroom lecture session. The core practice of this co-lecturing method is defined in four stages in about four to five weeks from topic selection, research and preparation, in classroom co-lecturing, to final report (see Table 1 in the Appendix). The most distinctive feature is at the third stage when instructor-planned classroom activities are seamlessly integrated with student presentations, and student presentations become an integral part of the lecture. The method can engage students better both before the class and during the class time. Students participate actively in the lecture design and presentation preparation, including writing study guides, compiling reading list, preparing short lecturing presentations, and setting up discussion plans. Because of the involvement of the instructor, this leads to improved preparation before presentation, improved presentation quality and effectiveness, and improved student attention and interactions during the class.

The following subsections describe the four stages of this collaborative process in detail: initiation, development, co-lecturing, and final report. Table 1 (in the Appendix) provides a summary of the stages.

3.1. Initiation

In the initiation stage, students will determine a topic area for further research. This phase is usually completed within the first 3 weeks of the semester. The instructor should prepare weekly schedule and topics for the whole semester, and also prepare a list of possible research topics that are aligned with the weekly schedule. The selection of the topic is not a simple assignment or a blind selection. First, the topics are carefully selected and are highly relevant to the class plan. The topics may be directly covered by the assigned readings or need additional research. The instructor should provide guidance to students in selecting a topic that they have interest in. Second, students will also conduct some initial survey of topics so they can have some ideas of what they are going to study. Students may propose topics but should consult with the instructor. Major activities in this stage are summarized in Table 2.

It is important for the instructor to explain the whole process and the collaboration requirement to students. It is also best for students to form teams based on their interests in the topic along with other factors such as schedule preference, teammate preference, etc.

Instructor	Students
• Preparing weekly schedule and topic areas • Introducing topic areas • Determining teams, topic area assignments, and schedule • Advising students on topic selection	• Forming teams based on interests, schedule, or personal connection. • Brief surveying of the topic areas • Selecting presentation date and topic area • Narrowing down to a specific topic

Table 2. Activities in the Initiation Stage

3.2. Development

The development stage lasts about three to four weeks on the topic research work and development of presentations. Unlike traditional student research and presentation preparation, the instructor is constantly involved in the preparation. On one hand, students study the selected topic and prepare presentations under the guidance of the instructor; at the same time, the instructor also plans and prepares the lecture that will incorporate student work. Instructor's plan may be adjusted based on student work. The preparation process may be unique for each team and their presentation.

The stage usually starts at least three weeks before the presentation date to ensure adequate research and preparation. Weekly meetings or updates are scheduled to facilitate the study and preparation process. Depending on how self-directed and organized students are, the instructor may take the project leader role to plan and monitor the progress. Major activities in this stage are summarized in Table 3.

At the end of this stage, the team will produce presentation slides with detailed content. The slides are not just for the purpose of presentation, but also can be used as lecture notes or study notes, with reasonable details and learning resources. Depending on the level and type of the course, students may also prepare a mini-study guide with overview, reading list, and discussion questions. The mini study guide will be distributed to the class with instructor's material before the assigned class date. The instructor may include an online component to the project in which students will create a public website to present their research and learning.

Instructor	Students
• Providing guidance and resources if necessary • Preparing and adjusting lectures and activities based on students' plan • Regularly checking in with students to keep them on track	• Studying the topic • Preparing presentation materials • Creating a website to cover the topic and provide resources • Interacting with the instructor to get feedback

Table 3. Activities in the Development Stage

3.3. Co-Lecturing

On the presentation day, typically, the instructor should start the lecture by introducing the topic with an overview. Depending on the topic, the student presentation may start at the very beginning, in the middle, or toward the end of the session. The schedule should be planned ahead by the instructor and shared with student presenters.

Normally, students will take control of the presentation. They will present, demonstrate, poll, or lead a discussion. The instructor will interact with the student teams and other students in various ways, depending on students' presentation and discussion leading skills and performance. The instructor will provide additional information and explanations at various times during the presentation, depending on classroom situations. The instructor can also ask planned questions or carry out planned activities at certain times to fulfill the course plan and enhance student interactions. The instructor may also have improvised actions based on audience responses, such as additional discussion on certain topics, more comments and feedback on particular concepts, or demonstration of additional resources.

The key practice is to gauge the level of student presentation performance and students' engagement, and act accordingly. If the student team does a good job at presenting and leading discussions, then the instructor can let students take more control and be more like a moderator or even an audience. If the student team does not perform well or is a bit off the track, then the instructor should be able to step in and take a co-presenter role. At these times, presenters will be in instructor-planned activities just like other students.

Although generally there is no time limit on the presentation as it is part of the lecture, it is still the responsibility of the instructor to control the pace and time so that it fits to the general class plan. The instructor will also provide feedback on the slides and suggest improvements for the final submission. Major activities in this stage are summarized in Table 4.

Instructor	Students
• Introducing the presentation at certain time point • Providing additional information and explanation at various times during the presentation • Inserting planned or improvised activities • Taking control if necessary • Controlling pace and time	• Presenting materials according to the plan • Responding to questions from the instructor and the audience • Leading discussions • Participating in instructor planned activities like other students

Table 4. Activities in the Co-Lecturing Stage

3.4. Report

In the final phase, students are usually given one week to complete the final report. The report package usually includes the finalized presentation slides, other learning materials (such as mini study guide), demonstration or prototypes development, and any supporting materials collected (such as documents, papers, web resources, images, video clips, etc.). Students need to further complete and compile the materials and report based on instructor feedback in the class. This may include adding additional materials, updating slides, correcting mistakes, adding references, etc. Students may also be asked to write a project summary and complete peer evaluations if applicable. All materials and resources can also be posted and updated on the website, and the class can continue the discussion online if the class would like to.

4. STUDENT FEEDBACK AND COMMENTS

The authors had practiced the Co-Lecturing method in a variety of information systems and technology courses in the past, each with some variations of the method (Table 5), as the method has been continuous developed and improved.

This method was implemented for the first time in an undergraduate level introduction to information systems course, which was offered as a night class in summer. Students welcomed the practice as they found the method interesting and they were engaged. The final student evaluation of the course is 4.8 out of 5.0. The following selected student feedback from the formal student evaluations represent some early success of the method.

> *"Fun class. The group presentation/ discussion format was very enjoyable and a great way to learn the info."*

> *"There was never a dull moment. The late night class was a joy after work hard all day at work -- you kept it interesting and exciting."*

IT/IS Course	Description
Introduction to Computer Information Systems	Undergraduate entry level, required for all business major students
Database Management Systems	Undergraduate level, required major course for the information systems degree
System Integration	Graduate level, required fundamental course for all IS students
Managing Data and Databases	Graduate level, required fundamental course for all IS students
Introduction to Information Security	Graduate foundation course for all MSIT students
Advanced Web Concepts and Applications	Graduate level, elective course for MSIT students

Table 5. Co-Lecturing Method Implementations in Past Courses

The most recent course in which this method was implemented is an advanced web concepts and applications course at the graduate level. At the end of the semester, as part of the continuing instructional improvement practice, a survey was distributed to the students asking for feedback. The survey includes a section with the following questions related to the Co-Lecturing method asking for qualitative feedback:

1. How did the co-lecture project impact the way you prepare for class and the learning process? Did you spend more time and do more readings? Were you more engaged?
2. Do you think you learn more from co-lecture (as a presenter) compared to other regular lecture sessions (where you are not a presenter)? In what ways?

3. How would you describe the instructor's role in the preparation process and presentation? Is instructor's involvement helpful?
4. Would you like to take more co-lecture or more regular lecture sessions (as a presenter) if time is not a constraint? Why and why not?

Selected student responses are organized in Table 6 (see Appendix) as either positive, neutral, or negative. The positive comments reflected expected outcomes; the neutral ones reflected some different student needs; the negative ones revealed the problems which we can address in the future. From the responses, students generally thought this method had let them think more from a teacher's perspective and forced them to organize their thoughts. There were two major problems reflected from student responses. The first one was related to the amount of work. The method does take a lot of time both from the instructor and the students. The second one was more specific about the lack of responses from an in-presentation survey, and the instructor should have provided more support.

5. DISCUSSION

As noted by other researchers in a similar study, there are several key factors that can affect the effectiveness of the co-lecturing approach. First of all, students have to take initiative to assume the responsibility for their own learning. Secondly, the instructor has to prepare the students adequately and maintain the role of coach throughout the process (Podl & Metzger, 1994). The key practice of the co-lecturing method is a good level of cooperation and collaboration between the instructor and the students. This collaboration is throughout the entire process to help motivate the students and provide clear guidance to ensure the success of projects.

During the development stage, it is important for students to complete their own study on time, and communicate with the instructor about the study progress. Having a good understanding of what students are doing can help instructor better plan the class session. A plan and regular meetings can help the project progress well. However, in real life situations, if it becomes a challenge for these regular meetings to happen, then it is important to establish a team leadership or correspondence of the team to ensure effective communication. As one student noted, "Most grads who also work are not going to be able to make meetings between the hours of 8am & 6pm. At times I felt the assigned person to go to the meetings was not giving updates in a timely fashion and having later meeting options would have made it easier for me to attend a meeting with the course instructor."

During the presentation, It is important for the instructor to control the classroom dynamics. Let students know and feel comfortable about the presentation format ahead of time. Let student presenters lead as much as possible, but take control if necessary. The instructor has to prepare for less performed student groups. For example, sometimes students read slides too much, then the instructor may want to jump in from time to time to start some conversation with the class to take the attention from the slides a bit. At other times, some students tend to talk about something irrelevant for a long time and the class seemed to get bored, then the instructor may want to remind students to move on.

Although the method is a good way to engage students, it is not for all course types and levels. The authors have found that the method is less effective in lower level undergraduate classes. This may attribute to the experience level of undergraduate students. The more experience the students have, the more they can look beyond just technical details, and the better they can handle the research and the presentation.

6. CONCLUSION

The primary advantage of employing the co-lecturing approach as a classroom teaching technique is its capability of engaging students both inside and outside of classrooms. This method is found to be more effective in teaching higher-level undergraduate or graduate level IT and IS courses where students often have higher self-motivation and can bring their own life or work experience. The structured four-stage approach helps to mitigate some of the challenges in peer learning and ensure the success of the teaching. Students have provided some initial positive feedback through surveys. Further research is recommended to provide more empirical support for the co-lecturing approach.

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Appendices

Table 2. Four-Stage Co-Lecture Method Summary

Stage	Overview	Time	Milestone
Initiation	Students conduct initial survey of subject domains, and choose a topic based on team interest and course plan.	In the first a few weeks of the semester.	Teams and topics determined
Development	Students conduct in-depth study and investigation of the topic under the guidance of the instructor. Students prepare presentation and other materials such as study guides and website. The instructor regularly meets with students and advises students to stay on the right track. The instructor may adjust class plan based on student work. The preparation process is also a group learning process.	Two to four weeks	Presentation slides, mini study guide
Co-Lecturing	The presentation is delivered as part of the lecture, with other instructor-prepared classroom activities seamlessly integrated into student presentations. The student presentation becomes an integral part of the lecture. The instructor plays a dual role of co-lecturer and audience depending on student performance.	During the assigned class time	In-classroom delivery of presentation
Report	Feedback is provided to students after the presentation so they can finalize and submit a final report package, which includes all presentation and learning materials.	A week after the presentation	Final report package

Table 6. Student Feedback Summary

Question	Positive	Neutral	Negative
#1	I was definitely more engaged. I prepared a lot more. First of all the topic was interesting. And I was able to relate it to my career goals a lot more.	When preparing for the lecture portion of the class, on the days that the groups were presenting the method was the same. Making sure I had the assigned readings so that I could contribute to the discussion.	I don't feel I was more engaged. I have done this before. I think it worked well for the rest of the class.
#2	Learned a lot more as co-lecturer. I had a vested interest in everything that was going on because I could see it for my career. You definitely learn more from the co-lecture as a presenter since there is quite a bit of research and you have a lot of back and forth discussion with teammates as to what we will and will not include in the presentation and reading assignments.	I liked it but I don't feel I learned more.	
#3	The course instructor's involvement definitely helped to narrow down the topics discussed. If we didn't have enough material the instructor had plenty of suggestions for additional things we could include. He is very helpful and prepared. He gives you links to material to help you get started.	Instructor's role is to give us a variety of topics to choose from. He/She should show enthusiasm in the lectures they do so we feel enthused. Then the professor should give us achievable guidelines and keep us within those guidelines i.e. we as students sometimes want to do so much, we can't possibly achieve it all. Quality over quantity.	I was disappointed in the rest of the class's participation when it came it the survey we passed out. Maybe, that can be encouraged more from the professor's level so they would feel more inclined.
#4	Definitely. It forces me to think from the other direction and use a part of my brain I don't use when just sitting there listening.	Probably a little more co-lecture because you are forced to really know the material in order to effectively lecture or conduct a discussion on it.	I like to present but I felt overwhelmed from other classes this semester.

Evaluating Students' Perception of Group Work for Mobile Application Development Learning, Productivity, Enjoyment and Confidence in Quality

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Abstract

Teaching programming and mobile application development concepts can be challenging for instructors; however, teaching an interdisciplinary class with varied skill levels amplifies this challenge. To encompass a broad range of students, many instructors have sought to improve their lessons and methods by experimenting with group/team programming. However, these studies focused on the instructor's usage of the method and not the students' perceptions of the method. This study was conducted to understand students' perceptions regarding the effectiveness of the student's group/team experience and learning outcomes when developing a mobile application. Results were favorable towards using group work for mobile application development learning, productivity, enjoyment and confidence of quality.

Keywords: programming, mobile application development, group work, team-based learning, collaborative learning,

1. INTRODUCTION

Many employers want technology savvy students that can collaborate with others nationally and globally. As a result, non-technology degree students are enrolling into technology based courses, including a computer applications/programming course to secure an edge in the job market. Thus, an applications/programming course may be considered interdisciplinary in nature.

Teaching programing and mobile application development concepts can be challenging for instructors; however, teaching an interdisciplinary class with varied skill levels amplifies the challenge. In an effort to find a solution to these challenges, many instructors have experimented with different collaborative learning techniques or software (Medina, Gomez-Perez, Neito-Reyes & Santos, 2013; Faja, 2014) or group/team learning methods.

There have been several similar studies that also found that students enjoy working in teams (Williams & Kessler, 2001; Cliburn, 2003; McDowell et al., 2006; Howard, 2007; Chigona & Pollock, 2008; Mentz at al., 2008; Zacharis, 2011). However, a study has not been found regarding students' perceived effectiveness of using group/team work for mobile application development in a hands-on programming environment. This exploratory study surveyed students to understand their perceptions of using group work for mobile application development learning, productivity, enjoyment, and confidence in quality. This work has practical implications for programming faculty and practitioners alike. The remainder of this paper is structured as follows: a brief review of programming pedagogy and collaborative learning (group/teamwork), the importance of engaging students through mobile application development, Stencyl, method, results, conclusions and limitations.

2. LITERATURE REVIEW

For years, it has been a challenge for students to learn programming skills (Sleeman, 1986; Ebrahimi, 1994; Faja, 21014; Jenkins 2002; Kinnunen et al. 2007; Mow, 2008; Nikula, Gotel, & Kasurinen, 2011; Powell & Wimmer; 2015). Babb et al. (2014) defined several known pedagogy failure mechanisms for students learning programming skills. One of pedagogy failure mechanisms reported was the lack of appropriate team/group work formats which support collaborative and peer driven learning.

Collaborative learning is "when a small group of students work together to complete an academic task" (Chinn & Chinn, 2009). Previous research has identified collaborative learning as a good instructional tool in higher education (Baer, 2003).

Michaelsen, Knight, and Fink (2004) expanded upon collaborative learning and developed a team-based learning (TBL) technique. Their technique TBL stresses the importance of using small groups to help apply key. TBL techniques has been used in the medical, engineering, business, sciences, technology, and liberal arts courses.

Lasserre (2009) adapted the TBL technique for a first semester programming class. She reported that student drop rates decreased as a result of using the TBL technique within her course. Lasserre and Sztostack (2011) further reported additional increases in grades as a result of TBL. A more current research study by Faja (2014) utilized conducted research on the use of paired programming for students. He defined paired programming as a collaborative learning technique that involves two students working together, side by side, sharing a computer to complete an academic task.

Faja (2014) examined students' perceptions on effectiveness of pair programming. He utilized a survey adopted from Chigona and Pollock (2008) and Howard (2007) to collect data from introductory computer programming classes. His results indicated that students perceived paired programming beneficial in learning and they also enjoyed paired programming.

Hu and Shepard (2014) utilized the process oriented guided inquiry learning (POGIL) to help teach first year programming students. POGIL is similar to TBL in that it uses student teams. However, POGIL is said to be better focused on concepts and process skills development. This study found that students who worked in teams using the POGIL method experienced increased grades.

Previous and current studies on group work/TBL in the classroom tend to focus on the typical programing languages, including, but not limited to, Visual Basic, Java, and C++ (Lasserre, 2009; McKeown, 2004,). There are few studies that focus on group work using mobile application development software.

A recent paper by Hoffman (2014) explains an interdisciplinary group approach for a game design, mobile web and application development course. Students utilized App Inventor for their mobile application development group project. It was found that some problems occurred within groups, in that, group members were delinquent or missing their parts. As a result, other group members had to pick up their work. It was also reported that planning and delegating issues occurred as a result of an open-ended project. However, the paper does not provide data on student perceptions regarding the usage of groups for mobile application development.

Importance of Engaging Students through Mobile Applications

Today, with the presence of advanced technologies and the extended availability of the smart mobile technology devices, many educators are exploring ways to enhance students' learning (Burd, Barros, Johnson, Kurkovsky, Rosenbloom & Tillman, 2012; Ching-Chiu Chao, 2006; Klopfer, 2008). While many educators may think that mobile technology is just another trend in the evolution of technology, smart mobile technology has morphed into much more than the next stage of the computer revolution partially because of its associated cost and student acceptance (Burd et al., 2012). Almost every incoming college or university student carries a smart mobile technology device. Madden, Lenhart, Duggan, Cortesi, and Gasser (2013) conducted a nationally representative phone survey study regarding smartphone adoption among American teens (ages 12-17). Their results stated that 78% of teens have a mobile device. More alarming, they reported that one in four teens are "cell-mostly" internet users. Cell-mostly users are defined as those who only use their phone to access the internet.

Another research study reported by Smith (2013) indicated that 91% of the adult population has a mobile phone/device. More specifically, he reported that 79% of college aged students (18-24) have a smartphone. To further explain the impact and importance of mobile devices, Smith (2010) stated that one in five individuals claim they would rather spend a week shoeless than a week without their mobile phone. Hall (2013) also believes that teens are obsessed with smartphones. He classifies teens as having a "mobile first" mentality to the Internet similar to Madden et al.'s "cell-mostly" Internet users.

Given the ubiquity of smart mobile technology devices and our social attachment to them, it is essential to engage students within a programming classroom via mobile application development. Today, mobile software creation applications such as Stencyl can be used to further apply students programming knowledge.

Stencyl (www.stencyl.com)
Stencyl is a downloadable application that is available free and in a paid version form to create mobile applications on your personal computer (PC), or Mac computer. Stencyl also has a jigsaw-puzzle piece graphical interface (GI) that has been very successful in previously developed programming applications such as Scratch (www.scratch.mit.edu), Turtle Logo (http://logo.codeplex.com/), Alice (www.alice.org), and App Inventor, (http://appinventor.mit.edu/). These applications focus on logic (Burd et al., 2012).

There is a limited amount of research conducted on the use of Stencly in the classroom. Most of the existing research has focused on programming or usability issues.

3. METHOD

The purpose of this research study is to understand the student's perceived value of using group work in hands-on applications/programming class to develop a mobile application. The research questions are:

1. In a hands-on programming course, how will students perceive group work when developing a mobile application?

2. In a hands-on programming course, how will students perceive the four category outcomes (perceived quality, perceived productivity, perceived learning and enjoyment) from using group work to develop a mobile application?

3. Will there be any significant difference between students mean scores among of the four category outcomes (perceived quality, perceived productivity, perceived learning and enjoyment) from using group work to develop a mobile application?

4. Will there be a significant difference between the gender perceptions in using group work to develop a mobile application?

Subjects were undergraduate students enrolled in a medium sized 4-year state institution. Students were enrolled in a traditional face to face section of an applications/programming course where students learn to program with Scratch, Visual Basic, and Stencyl. The purpose of this course is to present solutions for the business environment using Object Oriented Language (OOL) and other web-based development tools. The primary goal of the course is on programming. Students learn how to program within visual basic and other web based mobile application development tools such as Stencly. Students also learn how to develop usable applications including mobile applications. Approximately 75% of the course focuses on programming and the other 25% of the course focuses on how to design, develop, and work with applications.

Over a 14-week semester, the course consisted of three fifty minute classes per week (Monday, Wednesday and Friday). The class was a traditional face to face course held in a computer lab for a hands-on learning experience. The class was structured so that the first 3 weeks, students learned/worked with introductory programming concepts and Scratch.com. The following 8 weeks, students learned/worked with Visual Basic. Finally, the last 3 weeks' students learned/worked with Stencyl.

For the first 11 weeks, the instructor followed an "introduce, reinforce, apply, and assess" format. To introduce the concepts, the instructor held a lecture style PowerPoint session to go over key concepts for each chapter. To reinforce the key concepts learned, the instructor illustrated hands-on step by step ways to code for each chapter. To apply the key concepts learned, the instructor worked with the students by illustrating and guiding them in application development and programming. Finally, to assess the key concepts, the instructor gave a theory and a hands-on assessment. Each assessment was graded and distributed back to them within one week. An entire class period was spent reviewing each exam.

Throughout the 11 weeks, students learned basic programming concepts using Scratch and Visual Basic. Topics discussed were:

- Introduction to programming
- Program and Graphical User Interface Design
- Program Design and Coding
- Comments
- Variables and the Arithmetic Operations
- Decision Structures
- Loop Structures
- Using Procedures and Exception Handling
- Using Arrays and File Handling

The last 3 weeks of class, students worked with Stencly. Stencyl was placed towards the end of the semester because the students needed to learn the basic concepts before working with Stencyl. The instructor charged students with the task of working with in groups to create a mobile application using Stencyl. The students self-selected their groups.

The mobile application assignment was specifically left open-ended for the students to use creativity in their development process. The only graded requirements were that the application must have at least 3 different levels, 3 different objects and controls, as well as be classroom appropriate. Students were also required to create a story board of their mobile application.

Over the course of three weeks, students work with the instructor and their classmates to share ideas and build their mobile application. Each group briefly described their mobile application and then randomly challenged a student from a different group to come to the front of the room and try to use their mobile application.

Data was collected at the end of the semester via an IRB approved survey. The survey was adopted by Faja (2014) and modified to specifically address using group work to develop a mobile application. It is important to mention that Faja's (2014) survey was adopted from Chigona and Pollock (2008) and Howard (2007). Hence, this research survey was also adopted from the same researchers.

Our survey contained 12 questions/statements. The first two questions/statements were demographic in nature. The remaining 10 questions/statements were aimed at gathering information from the students regarding their perceptions of using group work for mobile application development. The survey used a Likert scale with response categories of Strongly Agree (5), Agree (4), Neither Agree nor Disagree (3), Disagree (2), and Strongly Disagree (1).

The survey was optional; students were not required to complete the survey. The instructor of the course was not present when the survey was electronically administered by another faculty member. The survey was anonymously completed by the students.

4. RESULTS

Statistical analyses were conducted using the Statistical Product and Service Solutions (SPSS) software. Various statistical test were used in this study. Specifically, a Cronbach's alpha analysis was used to test the reliability of the data set. Descriptive statistics were used to summarize the demographic data regarding the students. Also both descriptive and inferential statistic, including mean and standard deviation were used as a measure of central tendency and spread of the data set. Finally, paired t-tests, and two-tailed independent t-tests were used to test the research questions.

Reliability Testing
Reliability testing is typically used in survey instruments with summated and multi-point scales. The Cronbach's Alpha, which measures the internal consistency, is the most popular test for assessing reliability (Santos, 1999). When using the Cronbach's Alpha for testing reliability, "alpha coefficient ranges in value from 0 to 1 (Santos, 1999)." The typical acceptable Alpha reliability threshold is 0.7. Hence, the higher the Apha score, the better the reliability (Nunnaly, 1978; Santos, 1999). Reliability testing was conducted on the survey instrument. The Cronbach's Alpha was .946. Hence, this shows a good internal reliability because it is above the acceptable threshold score.

Descriptive Statistics for the Student Population

The overall sample size included 33 undergraduate business students enrolled in an undergraduate applications/programming course which is taught as part the Information and Technology Management (ITM) curriculum.

There were a total of eight different student groups within the course. The size of the groups ranged from three students to six student members. Specifically, there were three groups consisting of three student members, four groups consisting of four student members and one group consisting of six student members.

It is important to note that Institutional Research Board (IRB) approval required the survey to be anonymous and not mandatory for students. Therefore, collecting demographic information such as year of study and the discipline/major was not permitted. As a result, demographic data shown in Tables 1.1 and 1.2 was not collected via the survey. This data was retrieved from the university's student enrollment system and reported as a whole.

Table 1.1 shows the overall composition of the entire class with regards to their year of study. The data shows that there are few freshmen enrolled in the course and that majority of students are juniors or seniors.

	Frequency	Percent
Senior	4	15.10%
Junior	10	42.40%
Sophomore	14	30.30%
Freshmen	5	12.10%

Table 1.1 Year of Study for the Entire Class

Table 1.2 shows the overall demographic results for the students' discipline/major. The data shows that the majority of students are pursuing a Bachelor of Science (BS) in Business Administration (BSBA) degree with a specialty focus. Only 6% of the students enrolled in the applications/programming course are enrolled in Bachelor of Arts (BA) a degree program and 9% are enrolled in a degree program outside the college of business. This course enrollment data is not unusual for this applications/programming course because this course is taught by an ITM faculty within the college of business. This course is also an approved elective for college of business students.

	Frequency	Percent
BSBA Management	5	12.10%
BSBA ITM	13	39.40%
BSBA Accounting	2	6.10%
BSBA Marketing	2	6.10%
BA History	1	3.00%
BS Digital Forensics	1	3.00%
BSBA Finance	1	3.00%
BA Communication Studies	1	3.00%

Table 1.2 Major of Study for the Entire Class

Descriptive Statistics for the Collected Data Set
While the above demographic data describes the students enrolled in this course, it is important to note that the only demographic data collected from the survey was gender and age. Moreover, out of the overall sample size of 33 students, only 28 students completed the survey.

Table 2.1 reports the gender and age of the students that completed the survey. The majority of students (n=21) completing the survey were male. The majority of students (n=27) were traditional aged students. Only one student was non-traditional aged. This study defined traditional students as 18 to 24 years of age and non-traditional students as 25 plus years of age Greater than 24 years of age.

	Frequency	Percent
Male	21	75.00%
Female	7	25.00%
18-24	27	96.40%
>24	1	3.60%

Table 2.1 Gender and Age of the Survey Participants

Descriptive Statistics and t-Test Results of the Data Set

Descriptive Statistics were used to answer the research question 1 and 2. Table 3.1, located in the appendix, provides detailed questions responses. Specifically, the majority of students' responses are within the strongly agree and agree categories. These results suggest that the majority of students had a positive perception and experience with using group work in developing a mobile application. Additionally, Table 3.2, also located in the appendix, provides the mean scores for students' perceptions regarding hands-on-on group when developing a mobile application. The mean scores were all above 3.75 with the majority of mean scores above 4.0 "Agree". However, the perceived learning for question 8 was the weakest with respect to agreement.

Table 3.2 also shows the mean score and standard deviation for the dataset grouped into the four categories. The four categories are a measurement of effectiveness for confidence in quality, perceived productivity, enjoyment, and perceived learning. Confidence in quality was the mean score for the grouping of questions/statements 1, 2 and 3. Perceived productivity was the mean score for the question/statement 4. Enjoyment was the mean score for the grouping of question/statements 5, 6 and 7. Perceived Learning was the mean score for the grouping of question/statements 8, 9 and 10.

The results for each category also has mean scores close to or above 4.0 (Agree). This indicates that students agree that they are producing quality, are productive within their group, and enjoy group work when developing a mobile application.

While the mean scores and standard deviations provide insight into the students' perceptions, an effective measurement of the category outcomes is to test for a significant difference between the each of the four category outcomes. To answer research question 3, a paired t-test was performed on the data set. The results of the paired t-test indicated that there were no significant differences among any of the category outcomes. One can conclude that there is no significant difference because the four category outcomes are very close in score.

Additional statistical analyses were conducted to answer research question 4. To test the significant difference between gender and the four category outcomes, an independent t-test was performed. Results indicated that there was no significant difference between gender and confidence in quality, enjoyment or the perceived learning categories. However, there was a significant difference between the perceived learning category outcome's mean scores for males (M=3.87, SD=1.09) and female students (M=4.52, SD=.42), t(26)=1.52, p=.032). Specifically, females had a greater perceived learning in using group work to develop a mobile application in Stencly. Please reference Tables 4.1 and 4.2 in the appendix for details.

5. CONCLUSION AND LIMITATIONS

The results indicated that students have positive perceptions regarding using group programming for mobile application development. Our results are consistent with the results of similar studies that utilized a collaborative learning technique or a pair learning techniques. However, this research is important because as programming classes continue to become more interdisciplinary, the more important it is for educator's to engage and challenge all levels students using savvy mobile application software to further apply key programming concepts learned. Additionally, by having the student work in groups the instructor is making the students responsible for having a successful learning experience.

This study is not without limitations. This study had a small sample size and made no attempt to control for variables that may impact student perception of group work for mobile application development. Additionally, this study did not analyze if group size affected the students' responses. Therefore, it is uncertain if group size mattered. Additionally, students were surveyed after they presented their group's mobile application to the entire class. Prior to taking the survey, students received feedback from their instructor and classmates. Therefore, it is uncertain if the students honestly answered the questions or answered the questions based upon the instructor and classmate feedback. Furthermore, because the survey was anonymous, there was no way to test the differences between ITM and non-ITM students or working group size.

Nevertheless, this study demonstrated group programming for mobile application development can be used as a method to increase learning outcomes of a hands-on programming course. Future research should better control variables for construct validity. Additional research should be conducted with a larger sample size from various hands-on courses with several mobile application development tools in various computer lab environments over an extended period of time. Finally, future research should also be conducted on the effect of group size, as well as whether or not students who prefer group work actually do better when given that option versus students who are force to do group work against their preference.

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APPENDIX

Table 3.1 Percentage for Student Responses

Outcomes and Questions	Strongly Agree (5)	Agree (4)	Neither Agree nor Disagree (3)	Disagree (2)	Strongly Disagree (1)
Confidence in Quality					
1. I find that group programming develops better mobile application than developing myself.	25.0%	46.4%	5.0%	0.0%	3.0%
2. More errors were found and fixed with group programming.	35.7%	50.0%	3.6%	3.6%	7.1%
3. I was more confident in the work with group programming.	42.9%	46.4%	3.6%	0.0%	7.1%
Perceived Productivity					
4. The mobile application was developed quicker because of group programming.	32.1%	42.9%	10.7%	10.7%	3.6%
Enjoyment					
5. I enjoy programming / developing mobile applications with a group more than programming/developing alone.	35.7%	46.4%	7.1%	7.1%	3.6%
6. If I had a choice, I would work in a group again.	42.9%	42.9%	7.1%	3.6%	3.6%
7. I liked using group programming during the in-class labs.	39.3%	50.0%	7.1%	0.0%	3.4%
Perceived Learning					
8. I have learned more from doing the work because of group programming.	28.6%	39.3%	17.9%	10.7%	3.6%
9. It was helpful to discuss programming problems and solutions with my group.	50.0%	35.7%	3.6%	7.1%	3.6%
10. I think that using group programming during the in-class labs helped me better understand the concepts.	42.9%	35.7%	14.3%	3.6%	3.6%

Table 3.2 Question Mean and Standard Deviation

Outcomes	Questions	Mean	Standard Deviation
Confidence in Quality		3.99	0.97
	1. I find that group programming develops better mobile application than developing myself.	3.75	1.18
	2. More errors were found and fixed with group programming.	4.04	1.11
	3. I was more confident in the work with group programming.	4.18	1.06
Perceived Productivity		3.89	1.10
	4. The mobile application was developed quicker because of group programming.	3.89	1.10
Enjoyment		4.14	0.92
	5. I enjoy programming/developing mobile applications with a group more than programming/developing alone.	4.04	1.04
	6. If I had a choice, I would work in a group again.	4.18	0.98
	7. I liked using group programming during the in-class labs	4.21	0.88
Perceived Learning		4.04	1.00
	8. I have learned more from doing the work because of group programming.	3.79	1.10
	9. It was helpful to discuss programming problems and solutions with my group.	4.25	1.01
	10. I think that using group programming during the in-class labs helped me better understand the concepts.	4.11	1.03

Table 4.1 Category Means and Standard Deviations by Gender

Category	Mean	Standard Deviation
Confidence in Quality		
Male	3.95	1.08
Female	4.10	0.57
Preceived Productivity		
Male	3.81	1.21
Female	4.14	0.69
Enjoyment		
Male	4.03	1.10
Female	4.48	0.47
Preceived Learning		
Male	3.87	1.09
Female	4.52	0.42

Table 4.2 Results of T-test

Category	Sig.	T	Df	Sig (2-tailed)	Mean Difference
Confidence in Quality					
Equal variance assumed	.511	-.333	26.00	.742	-.143
Equal variance not assumed		-.449	20.25	.658	-.143
Perceived Productivity					
Equal variance assumed	.141	-.687	26.00	.498	-.333
Equal variance not assumed		-.898	18.69	.380	-.333
Enjoyment					
Equal variance assumed	.290	-1.11	26.00	.275	-.444
Equal variance not assumed		-1.58	22.78	.129	-.444
Perceived Learning					
Equal variance assumed	.078	-1.52	26.00	.140	-.651
Equal variance not assumed		-2.27	25.08	.032	-.651