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Teaching Accessible Design: Integrating Accessibility Principles and Practices into an Introductory Web Design Course

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Abstract

Curb cuts and automatic doors are a commonplace in the physical world as they provide access to our buildings for persons with disabilities. In the world of the web, millions of individuals have the legal right to rely on electronic curb cuts so they too can access the web. To this end, a new generation of information systems graduates must understand the dynamics of accessible web design. However, this subject is commonly taught as an add on topic with minimal impact on student knowledge and practice. Thus, the purpose of this article is to present an integrated approach to teaching accessible web design in an introductory web design course. The main contributions of this paper include (1) a background on web accessibility, (2) a review of pertinent assessment tools and legislation, and (3) a model for integrating web accessibility into an introductory web design course.

Keywords: Computing education, accessible design, web accessibility, integrative learning.

1. INTRODUCTION

As the world of the web continues to grow, its architects and caretakers serve an important role in the development and maintenance of an accessible digital world. In principle, the world of the web should be accessible to all regardless of their physical, sensory, or mental ability (W3c 2019b). However, in practice, this is not always the case because most sites found on the web contain some form of inaccessible elements that could have easily been remediated had the developer implemented some fundamental accessible design practices (Wettemann & White, 2019). Such inaccessibility can have a huge impact on businesses and institutions considering that nine in ten American adults use the internet and one in five has a disability that may affect their ability to use the internet (Teach Access, 2019b). In addition to the business perspective, many countries have legal requirements related to website accessibility (W3C WAI, 2019a).

Web developers who incorporate accessible design practices into their development process are in demand. In response, organizations and consortia such as AccessComputing, TeachAccess, W3C, and WebAim (AccessComputing, 2019; Teach Access, 2019a; W3C WAI, 2019c; WebAIM, 2019a) have worked to support and increase the numbers of faculty teaching and professionals practicing accessible design. While these resources are increasingly becoming more available, many information systems, computer science, and other interdisciplinary computing faculty feel they do not know enough about accessibility to teach the subject. Unfortunately, there is a lack of resources to help inexperienced faculty to incorporate accessibility topics into their curricula (Putnam, Dahman, Rose, Cheng, & Bradford 2016). When 1,857 computing and information science faculty members were surveyed, only 20% indicated that they incorporate topics about accessibility into their courses (Shinohara, Kawas, Ko, & Ladner, 2018). This is evident considering accessible design is typically not a fundamental component

to classroom instruction or textbook topics (Rosmaita, 2006).
In 2016, Putnam et al. examined how schools incorporate accessibility topics into their curriculum. They found a wide range of approaches which included standalone programs, standalone courses, integration throughout the entire program, integration throughout a single course, and as a module. When the researchers interviewed faculty, they found the most common prevalent practices were to either create a single course or provide a module in another course.

The aforementioned approaches have their benefits and disadvantages (e.g., deep dive in a single course vs. topic related exposure with a module). One approach that is particularly advantageous to the learning process, as supported by the Integrative Learning theory (Leonard & Jean, 2007; Leonard 2012), is the integration of accessible design principles and practices into the normal progression of a given course. Doing so allows students to make connections between accessible design and web development while they are "in the moment" of learning.

By teaching accessibility throughout the semester, students become more robust developers who view accessibility as part of the process rather than an afterthought. While multiple arguments can be made as to why information systems graduates must understand and implement accessible design practices (e.g., business, social responsibility, technological advancements, etc.), the bottom line is that accessible design practices should be as fundamental to our graduates as digital literacy. As more and more information systems and computing programs integrate web development courses into their curriculum, it is imperative that students understand the importance of integrating accessible design practices into the development process.

As previously indicated, researchers have identified a lack of instructional resources that are available to assist faculty with the incorporation of accessibility into their courses (Putnam, Dahman, Rose, Cheng, & Bradford 2016). Therefore, the overall purpose of this work is to assist faculty by contributing to the limited accessible instruction resources.

2. ALTERNATIVE METHODS FOR ACCESSING THE WEB

Before discussing accessible web design, it is important to discuss the interplay between adaptive technologies and web access/interaction. Adaptive technologies enable individuals with disabilities to access and interact with a web page by modifying a web page's content and interaction into a usable format. To this end, adaptive technologies are reliant on a web page's level of accessibility. If accessibility elements are lacking, then the adaptive technology's ability to convert page content into a usable format is hindered.

For example, a person who is blind could have a refreshable Braille device convert a web page into Braille. However, the Braille device is reliant on the electronic curb cuts built into the page (as are other adaptive technologies). To expand, consider a web page that describes how a computer works. Found on the page is a picture of the inside of a computer with all the parts labeled. If the image is not described with the alt text or the long description attribute, then the Braille device can only inform the user that an image exists. Nothing more. Any meaning found within the image (e.g., the different parts of a computer) is lost.

There exist a wide range of adaptive technologies to help individuals interact with the digital media found on the web. Some are hardware, some are software, and some are both. Table 1 (see Appendix) provides a general overview of how some individuals with various conditions use technologies to access web-based materials.

3. ACCESSIBLE WEB DESIGN: TECHNOLOGICAL, LEGAL, AND BUSINESS PERSPECTIVES

Integrating accessible design principles and practices into the progression of a web design course prepares graduates to handle future workforce responsibilities. From a technological perspective, graduates need to understand that accessible design enables a wide range of use by persons with disabilities and current technologies utilized by the general population. An example of this multi-use scenario is a voice-activated navigation program. Such a program can serve individuals who are blind (e.g., "fastest walking route to library") as well as drivers (e.g., "nearest gas station").

In terms of a legal perspective, many countries have instituted web accessibility regulations that require adherence. For example, the U.S. Congress enacted legislation to require public institutions to develop websites that are accessible to persons with disabilities. As part of that legislation, the U.S. Access Board created Section 508 Standards for Electronic and Information Technology (1998) and in 2017, the standards were revised to require 38 of the 61 new guidelines (Section 508, 2017) be met rather than the original 16 (Section 508, 2000). Further discussion on the guidelines is found in a later section.

By not complying with legislation, businesses run the risk of ending up in court. Companies such as Wells Fargo, H&R Block, and Target have had accessibility lawsuits brought against them. The result of which was substantial amounts of money being paid to the plaintiffs and civil penalties (Court Listener, 2009; LEAGLE, 2007; United States Department of Justice Civil Rights Division, 2011; United States Department of Justice, 2013). In addition, companies with inaccessible websites have had to pay millions to charitable organizations (United States Department of Justice Civil Rights Division, 2011).

Students should also understand the importance of accessible web design from a business perspective. More so, millions of people with and without disabilities around the world rely on well-designed web media. If this media is not accessible, a business could lose customers, inadvertently discriminate against employees with disabilities, experience lower rankings with search engines and reduced site traffic, and ultimately lose money. Concerning money loss due to low internet search rankings, Moreno & Martinez (2013) found that search engines interpret an accessible website as an indicator of quality and that the accessibility features allow for the search engine to better access and index a web page's content. To this end, search engine optimization (SEO) is tied with website accessibility.

Given the importance of web accessibility, faculty should be graduating information systems and computing students who incorporate accessible design practices into their development process. While faculty support the idea of teaching accessibility, barriers to doing so include their lack of expertise and sub-area materials (Shinohara et al. 2018). The following aims to help faculty overcome these barriers.

4. ACCESSIBLE WEB DESIGN INSTRUCTION

When instructing on accessible web design principles and practices it is important to incorporate the most recent assessment tools, accessibility standards and practices. As of January 2019, the current U.S. and international standards for web accessibility can be found in the Web Content Accessibility Guidelines 2.0 (2019c). The following includes a review of WCAG 2.0, assessment tools, followed by an alignment of WCAG guidelines to a typical intro to web development course.

WCAG 2.0 Explained

In the simplest terms, accessible web design can be defined as the creation of web resources in a manner that is usable by all. W3C has sought to maximize the usability of web resources through the creation of WCAG 2.0 which consists of four principles that branch into 12 guideline categories which further branch into 61 specific guidelines. Success criteria for these guidelines are based on three levels of conformance - A, AA, and AAA. Each level requires conformance to the previous level. A page that conforms to level AA is considered to be reasonably accessible and conforms to U.S. legislative requirements. A page that also includes level AAA requirements can be considered highly accessible. For example, providing captions would meet level A and providing captions and a sign language interpretation would meet level AAA. Captions alone in this situation would be considered reasonable.

It should be noted that WCAG 2.0 (2019c) was updated to WCAG 2.1 in June 2018 (2019d). For the most part, the update expands upon 2.0 to improve accessibility for users of mobile devices, users with low vision (a.k.a., "partial sight"), and users with cognitive or learning disabilities. To date, resources have not been developed to fully implement the updates. However, updates that relate to an introductory web design course will be discussed.

Accessibility Assessment Tools

The accessibility assessment of a web page is typically accomplished in two stages. First and foremost is to check if the page is technically correct (e.g., proper use of structure and markup). W3C's Markup Validation Service (2019a) is a free resource that should be in every student's (and professional's) toolbox (Figure 1). This service provides a detailed report on technical issues found in a web page. If these technical issues are not addressed, the functionality of adaptive technologies used to

access web pages can be hindered. For example, if an <h1> is not closed then a screen reader might treat all content on a page as an <h1>.

Once a page is to be determined to contain valid HTML, the second stage is to assess for accessibility. W3C provides a list of 92 web accessibility evaluation tools that can help students determine if their web content meets accessibility guidelines (W3C 2019b). While there

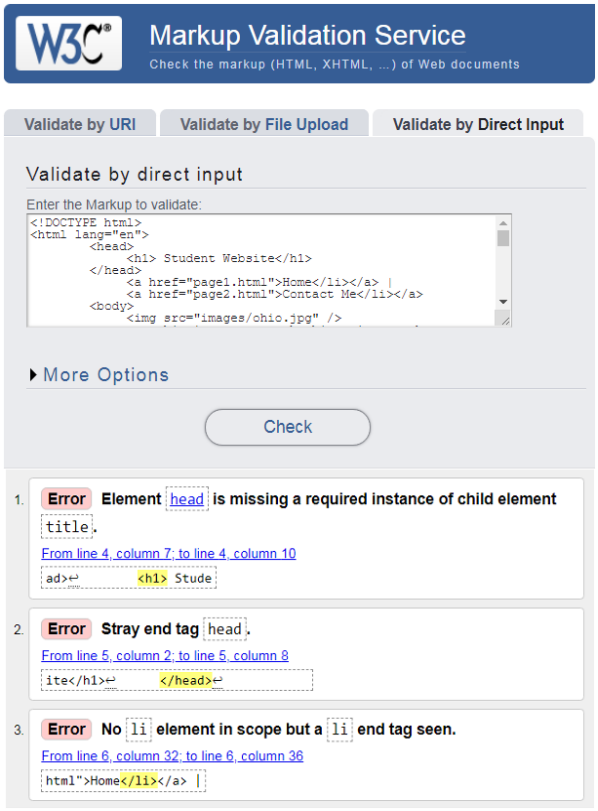

Figure 1: W3C's markup validation assessment results

are many tools available, students tend to appreciate AChecker (2019) as it is free, and reports are easy to understand (Figure 2). In addition, AChecker allows the user to choose which set of guidelines they would like to assess against. Its default is the U.S. standard of WCAG 2.0 set to level AA. While the accessibility evaluation tools help to automate the process, human input is needed for multiple guidelines (W3C WAI, 2019d). For example, the automated process cannot check for captions or if the captions are correct.

W3C's Markup Validation Service and AChecker are invaluable instructional resources as they enable students to independently understand and improve their web development practices. Additionally, both tools facilitate the grading process as they automate the error finding process. Over time, the use of these tools should become part of a student's development process - especially when attempting to identify why their page is acting inappropriately. The timing of introducing these tools will be discussed below.

Once students are exposed to the assessment tools and guidelines, instruction on the guidelines can be done in a manner that complements course content as the semester progresses. An appropriate application of this approach is to include accessibility guidelines during lectures and assignments for any given topic that directly relates to accessible design. By doing so, the connection between classroom concepts and accessibility practices can be strengthened.

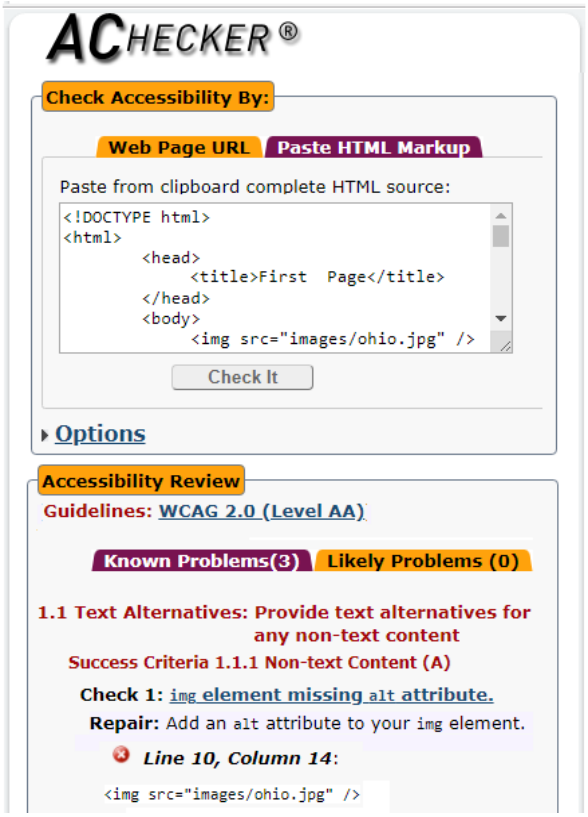

Figure 2: AChecker accessibility evaluation results

5. INTRO WEB DESIGN COURSE PROGRESSION

A fundamental concept of this work is the promotion of an integrated instructional approach where accessible design principles and practices are part and parcel to the progression of course content. Whenever course lessons have a corresponding accessible design approach, the approach is also integrated into the lesson.

The following is a step-by-step representation of course topics as they would commonly appear in a typical intro to web design course progression, their corresponding accessible guideline and importance, and a teaching tip discussion. While the following includes Hypertext Markup Language (HTML) and Cascading Style Sheets (CSS), it is understandable that not all intro courses will include the same content. To this end, readers can pick and choose which sections apply to their course. The reader will also note that some of the accessible practices might already be covered in an introductory course (e.g., valid HTML). However, the takeaway point is the relationship and importance that practice has to accessibility. Lastly, not all guidelines are present in the following material. This is purposeful as the focus of this work is to complement the introductory course and start the development of an accessible design mindset among students.

It should be noted that this work has been developed over multiple semesters by the same instructor who incorporates active learning in a flipped classroom environment. The delivery of the course is as follows. Readings are assigned and completed before class. The readings are made up of material from the textbook and external accessibility materials (when appropriate). Classes start with a short lecture and discussion where topics are reviewed in preparation for the upcoming activities. If there was an accessibility component in the readings, then students can expect to integrate said component into their upcoming activities and coursework. Activities and coursework include small labs, larger projects, quizzes, and exams.

Hypertext Markup Language

The difference between accessible HTML and non-accessible HTML is a slight one. With a few additions and modified implementations, non-accessible markup practices can easily be remediated. As previously indicated, adaptive technologies (and others) rely on the correct implementation of the semantic and syntactic markup found on a page. For the most part, an accessible designer needs to be conscious of the small tweaks to make a page accessible.

To this end, complementing HTML instruction with accessibility features is a straightforward process that takes a minimal amount of time. For example, when presenting on images it would take less than two minutes to discuss why one would need to include an alternative description for people who cannot see the image. Requiring alternative descriptions on assignments and testing on their importance/implementation reinforces good practice.

Valid HTML

Structure and markup are some of the first things a student learns in an introductory course. As modern devices and accessible technologies rely on valid HTML, students should develop valid code from the beginning. At this point in the progression of the course, the student should be introduced to W3C's validator (2019a) and begin learning how to check their work. By validating their work, they are complying with WCAG Success Criterion "4.1.1 Parsing: In content implemented using markup languages, elements have complete start and end tags, elements are nested according to their specifications, elements do not contain duplicate attributes, and any IDs are unique, except where the specifications allow these features" (W3C, 2019c).

At times, textbooks introduce the DOCTYPE declaration discussion (i.e., <!DOCTYPE html>) later in the chapters. This topic should be moved up before the use of W3C's validator as its presence is required by the validator.

<title> & <html lang="en">

The title element serves to orient the user to the content without having to process the content (WCAG Success Criterion 2.4.2) and the lang attribute serves to identify the language used throughout the document (WCAG Success Criterion 3.1.1). An example of the importance of the <title> tag is a page that contains a large amount of top matter (e.g., navigation, advertisements, etc.). A sighted user could scan past these elements and understand what the focus of the page is but a person who is blind would need to have their screen reader process all the top matter before discovering the focus of the page. A quick check with W3C validator or AChecker will reveal to the student whether or not they have included title tag and lang attribute.

Headings <h1>, <h2>, <h3>, <h4>, <h5>
Headings are utilized by adaptive technologies to quickly navigate a web page. It is important that they be used to describe a topic or purpose (WCAG Success Criterion 2.4.6) rather than for visual effect. In addition, headers should be used with an appropriate hierarchy structure. Manual checks are needed as automated checkers will not pick up on contextual use.

<a href....>
Link names need to be purposeful / in context (WCAG Success Criterion 2.4.4). Adaptive technologies can list all the links on a page so a user of adaptive technologies might scan them as quickly as a visual user might scan a page. If the links are not meaningful such as "click me" or "click here" then they become useless to the user of adaptive technologies. Validation tools will not be able to identify if a link is purposeful.
<nav>
Users of screen magnification are reliant on their spatial memory for items on a page. To this end, consistent navigation across multiple web pages (WCAG Success Criterion 3.2.3) eases the burden of memorizing a different layout for each page. Human input is required to assess consistent navigation.

<img>
Images (non-text content) visually convey information and are inaccessible to those who cannot see them. Consequently, a text alternative is required (WCAG Success Criterion 1.1.1). This is typically accomplished with an alt attribute which provides a concise description of the image. If a short description is not enough for a complex image then the use of the longdesc attribute is necessary (e.g., link to a detailed description). Examples would include an alt= "two baby ducks on the water" for a short description of two ducks or longdesc= "http://www.doublehelix.com" for a long description of a double helix. Both W3C validator and AChecker will identify images with no alt attributes but human input is required to determine the need for a longdesc attribute.

As students explore images (e.g., JPEG, PNG, GIF), it is important to address GIF images that flash more than three times per second. According to WCAG Success Criterion 2.3.1, anything that flashes more than three times per second can cause an individual with a seizure disorder to have a seizure. While other accessible design practices address the removal of access barriers, WCAG Success Criterion 2.3.1 directly addresses a practice that can cause a medical issue (i.e., seizure). To this end, students must learn early on to never include anything that flashes more than three times a second. This Success Criterion should be taken into consideration with CSS techniques discovered later in the semester. Human input is required to assess flashing content.

<table>
Tables can range from simple to complex. For those that cannot see a table, it becomes more and more difficult to relate individual cell data to a specific row and column the more complex a table becomes. According to WCAG Success Criterion 1.3.1 Info and Relationships: Information, structure, and relationships conveyed through presentation can be programmatically determined or are available in text. Depending on the complexity of the table, this means the inclusion of caption, summary, headers, and scope. For simple tables, caption and headers are sufficient. More complex tables require all four. Human input is required to determine the complexity of a table.

<form>
Forms provide the user with a means to interact with a website. For a form to be usable, it must be navigable (WCAG Success Criterion 2.4.6) and provide input assistance (WCAG Success Criterion 3.3.2) as accomplished with the <label> element and the <fieldset> and <legend> grouping controls. A <label> element is required on all form controls, but the implementation of grouping controls is reliant on the complexity of the form. An example of the importance of the <label> tag can be explained with a simple form that has a handful of inputs (e.g., name, age, date of birth, etc.). If the form does not have labels, a screen reader will not be able to inform a blind user which input field their cursor is currently located. When the label is used, the screen reader can inform the user what input data is expected. AChecker automatically identifies missing labels.

WCAG 2.1 added WCAG Success Criterion 1.3.5: Identify Input Purpose to help individuals identify and understand the purpose of form inputs. The best recommendation for doing so is by using the autocomplete attribute which describes the meaning of a given value. As of writing, AChecker does not assess for 1.3.5.

<audio><video>
Individuals who are deaf or hard of hearing are not able to process audio content found in audio and video and individuals who are blind are not able to process visual information presented in videos. To this end, the audio needs to be

captioned and video needs an audio description (WCAG Success Criterion 1.2). As the creation and manipulation of audio and video are out of the scope of an intro class, it is best to discuss the implications and responsibilities of including audio and video on a web page.

Audio that automatically plays can make it difficult for those who use screen reading software to process the automatic audio and the screen reader audio at the same time. This condition makes it important for the individual to be able to control the audio by either stopping it or controlling the volume independently from the system volume level (WCAG Success Criterion 1.4.2 Audio Control). To this end, students should learn to include controls with their audio or video (e.g., <audio controls>).

Cascading Style Sheets
At this point in the course, students have learned how to create accessible content with properly structured HTML. With CSS, students will need to become more reliant on their ability to identify and incorporate accessible design principles and practices into their development process. The need for this change is because most automated accessibility checkers are unable to identify CSS based accessibility issues. However, at this point in the semester, accessible design is nothing new and the following accessibility recommendations are within a student's ability to incorporate into their design process.

Color
One of the early stages of CSS instruction is the manipulation of color on HTML elements to enhance aesthetic appeal. While fun, students should understand that many individuals experience limited color vision (e.g., color blind, partial sight, blind, etc.) and therefore have difficulty perceiving color. To this end, color should not be used as the only visual means to convey information, indicating an action, prompting a response, or distinguishing a visual element (WCAG Success Criterion 1.4.1). Examples include "click the red…" or "yellow indicates required". For the most part, students should learn not to use color in such cases. Although, if it is required, an alternative means such as alternative text for an icon should be used. Human input (e.g., the developer) is required to determine if color is being used appropriately.

Contrast
Individuals with moderately low vision rely on the contrast between text and its background so they can read the text. WCAG Success Criterion 1.4.3 requires at least 4.5:1 for normal text and 3:1 for large text. WebAIM (2019b) provides a free online color contrast checker which is simple for students to use.

Layout
HTML is processed top to bottom by the browser and various adaptive technologies. With CSS, it is possible to change this sequence and locate content anywhere on the page (e.g., static positioning, float). Doing so can create a new content representation sequence that takes on a different meaning than the sequence found in the HTML. WCAG Success Criterion 1.3.2 puts forth that it is acceptable to position content throughout the page for visual effect, but the sequence found in the HTML must be maintained.

Flashing with Animation
As stated previously, anything that flashes more than three times per second can cause an individual with a seizure disorder to have a seizure (WCAG Success Criterion 2.3.1). With CSS it is possible for students to use the animation property to create an effect that can cause a seizure (i.e., animation-duration: .25s; animation-iteration-count: 10;). Students must learn to never implement anything that flashes more than three times per second. To this end, if the animation property is part of the course progression then it should be used with caution by both the faculty and students.

Responsive Design
According to WCAG 2.1 WCAG Success Criterion 1.4.10: Reflow, content should be presented without the need to scroll in two dimensions. To expand, people with low vision magnify a page and upon magnification, this page should flow into one column so scrolling is only necessary for one direction (typically vertical). To this end, students should learn about the use of static dimensions as a practice that should only be used if necessary (e.g., the two-dimensional layout is needed for meaning) as a fluid design is more appropriate.

6. TEACHING EXPERIENCE

This approach to infusing accessible design principles and practices throughout the semester stemmed from the need to improve upon the single accessibility lecture approach. To expand, the course was taught with a single accessibility lecture over a period of 1.5 years. This practice created a trend where many students would only design accessibly if there was an explicit

requirement to do so. Rather than updating assignment requirements and furthering the perception that accessibility is only needed when required, the instructional approach for the course was updated to instill upon students that accessibility is a fundamental component of the web design process. Overlooking its inclusion constituted sub-standard work.

Over the past two years in the introductory web design course, the integrated approach positively influenced how the students perceived and practiced accessible design. More so, once an accessibility principle or practice is covered, there is an implicit expectation that it will be included in future work. Failure to include accessibility practices results in a point deduction which was rarely needed to enforce as the semester progressed. By integrating accessible design early and often, a solid foundation is created on which students can build upon and, ultimately, become professionals capable of understanding, creating, and maintaining an accessible digital world.

7. CONCLUSION

As previously indicated, many faculty have reported a lack of accessibility expertise and sub-area materials. Furthermore, only 20% of faculty teach courses that incorporate accessibility topics (Shinohara et al. 2018). The result of this is a generation of graduates who do not know about accessibility. This is problematic as 63% of companies reported that their staff does not have enough accessible technology skills (Teach Access, 2019b). If this is to change, faculty will need to incorporate accessibility into their teaching practices and, on a larger scale, departments will need to examine how accessibility can be integrated into the core curriculum. To this end, the following are recommendations on how to improve, through research and practice, the current status of accessibility instruction.

- Investigate where accessibility instruction fits into specific courses/topics (e.g., software engineering, mobile application development, etc.).
- Investigate what motivators lead to the adoption of accessibility instruction.
- Create and disseminate materials/modules that can be directly integrated into specific courses and topics.
- Develop instructional opportunities for faculty to learn the importance of accessibility and how to integrate accessibility into their course.

As our digital world continues to grow, it is important that a new generation of information systems and computing graduates are prepared to maintain/create new spaces and interactions that are accessible to all. With a collective effort, academia can help make this happen.

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Appendix

Condition	Accessibility Barrier	Technologies used to Overcome Barrier
Blind	Visual materials	Screen Reader
Color Blind	Use of color	Custom Cascading Style Sheets
Low Vision	Content size	Screen magnification program
Mobility Impairments	Hardware requirements such as mouse use (e.g., click here)	Keyboard entry, voice activated control, switches, eye gaze technology, etc.
Deaf / Hard of Hearing	Audio cues, audio tracks	Sound notification, amplification

Table 1. Web Access Barriers and Practices

Applying Agile Across the IT Curriculum

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Abstract

Agile is emerging as a new paradigm for organizations across a variety of industry sectors because Agile helps teams manage and adapt quickly to change. In order to provide our students with workforce ready skills and better performance in group projects, a regional campus Computer and Information Technology (CIT) department began implementing Agile across its curriculum. After a visit to a local business who underwent an Agile transformation and is now using Agile for all their teams, they said that understanding the culture of Agile is more important than the practices themselves. Revising our curriculum allows us to give our students the advantage of learning how to be Agile and what it means to thrive in an Agile culture.

Keywords: Agile, Curriculum Development

1. INTRODUCTION

An IS/IT education program at a public university is incorporating the Agile way of working into its curriculum to meet industry demand and to improve teaching and learning outcomes. Agile continues to be the leader in organizational transformations due to its ability to rapidly respond to change, no matter the industry sector. According to ICAgile, "agile is not a process, methodology, or framework; it is a mindset that welcomes uncertainty, embraces challenges, empowers individuals, and views failure as a learning opportunity. Adopting an agile mindset unleashes the brilliance of people and teams, which enables rapid discovery and faster innovation" (ICAgile, Mission, n.d.). In order to prepare our students for the IS/IT workforce, we have evaluated every course in our curriculum and incorporated Agile values and practices into them. We have also developed an Agile concentration in our department that offers three different ICAgile certifications. The IS/IT faculty are even using Agile to advance strategic planning initiatives, manage department meetings, and help other campus departments with their goals. If we are going to teach Agile, our department and our faculty must become Agile.

2. MOTIVATION

An Agile organization is starting to emerge as the new leading organizational paradigm (Ahgina, De Smet, Lackey, Lurie, & Muraka, 2018). Based on industry reports, the shift to organizational Agility is a direct result of the rapid changes in "competition, demand, technology, and regulations" (McKinsey, 2017, p. 1). According to a 2017 McKinsey Global Survey on organizational agility, two-thirds of respondents indicated their business sector is characterized by rapid change. This new "normal" of rapid change means that organizations need to respond and adapt quickly in order to remain competitive. The need for

"organizational agility," which McKinsey (2017, p.1) defines as "the ability to quickly reconfigure strategy, structure, processes, people, and technology toward value-creating and value-protecting opportunities," is becoming a need in industry. Even though the business environment is changing, organizations are lagging in implementing Agile practices to help them respond to change (McKinsey, 2017).

While companies are struggling to transform their workforce to an agile organization, being Agile is a top priority (McKinsey, 2017). The success of an organization's Agile transformation depends highly on the culture. A 2018 McKinsey report found that only four percent of organizations have completed an organization-wide Agile transformation. The number one problem cited by the companies who failed is culture (De Smet, 2018). Becoming an Agile organization is a threat to middle management, which is often there to communicate, guide, and control (De Smet, 2018). In an Agile organization, teams are self-organized, and there is no "manager," which is a threat to middle management. This threat can cause the transformation to stall as employees struggle with their new roles. The Agile way of working also challenges the non-management employees as well. They are used to having a manager approve most decisions, but in Agile, teams are empowered to make their own decisions, which requires a change in culture and thinking.

Eighty-one percent of organizations who have successfully completed an Agile transformation report that they have seen a "moderate or significant increase in overall performance" (McKinsey, 2017, p.2). After adopting Agile, organizations reported seeing improvements in many areas (only the top five are reported here): 71% reported improvement in the ability to manage changing priorities; 66% reported an increase in project visibility; 65% reported an increase in business/IT alignment; 62% reported an increase in getting product to market; 61% reported an increase in team productivity (VersionOne, 2017).

Agile improves the productivity of groups across the enterprise (Comella-Dorda, Kaur, & Zaidi, 2019). Agile teams are more successful because the Agile way of working helps them focus on a small set of strategic priorities, helps teams to have clear goals, accelerates planning cycles and reallocate resources, and enables self-organized teams. This same success has been reported in group work in higher education settings (Woods & Hulshult, 2018; Hulshult & Krehbiel, 2019). These recent research studies have found that students who are taught by instructors who use Agile practices and techniques in the postsecondary classroom have enhanced learning experience and outcomes. Hulshult and Krehbiel's (2019) research found that Agile helped to improve the quality of student group projects and enhanced their learning. A 2017 study reported that students credited the use of Agile in the classroom with a more effective learning experience and more efficient use of their time. This same study also reported that students credited Agile with enhancing teamwork on group projects and the quality of class project deliverables (Krehbiel, Salzarulo, Cosmah, Forren, Gannod, Havelka, Hulshult, & Merhout, 2017). Agile scholarship is also increasing in higher education. Agile methods are being used in courses in computer science, software engineering, information systems management, supply chain management, technical writing, early childhood education, civic studies, and political science (Krehbiel et al., 2017). Pope-Ruark (2012) has successfully used Agile practices in her English classes in complex group projects to encourage trust, engagement, and accountability among students.

We have begun to implement Agile across our Computer and Information Technology (CIT) curriculum to better prepare our students for an Agile workforce and help their performance in group projects. After speaking with several employees who work for an Agile company, they said that understanding the culture of Agile is more important than the practices themselves. Evaluating our curriculum allowed us to give our students the advantage of learning how to be Agile and what it means to thrive in an Agile culture.

3. CURRICULUM PLANS

Adding Agile practices to our curriculum has two main parts. One part involves revision of existing courses to include the use of Agile practices, teaching of Agile concepts, and activities designed to develop an Agile mindset in students. The other part involved designing an Agile concentration to allow interested students to explore Agile in depth. The department is also engaged in a number of activities to support these efforts.

Current Curriculum

The Computer and Information Technology (CIT) department offerings include a Bachelor of Science in information technology with majors in either Information Technology or Health Information Technology (HIT). We also offer an associate in applied science degree with majors in Computer and Information Technology and Computer Technology.

The overall structure of the degree requirements for the two bachelor's degrees are similar. The bachelor's in Information Technology degree requirements completion of 124 credit hours, as shown in Table 1. The curriculum includes a set of required core CIT courses, a three-course CIT concentration, technical electives, university general education requires (15 credits of which are met by required CIT courses), and additional free electives.

Currently, two CIT concentrations are offered – networking and software development and support. The BS in IT program includes a three-semester self-directed capstone experience.

Component	**Credits**
Required CIT core (including capstone)	44 – 45
CIT Concentration	9
Technical Electives	6
General Education	50
Free Electives	14 – 15
Total	**124**

Table 1. BS in IT curriculum components. The majority of courses in the curriculum are three-credit courses.

The HIT program requirements are similar, with the addition of several courses to develop knowledge specific to healthcare and HIT with a matching reduction in free electives. The HIT degree requires a two-semester capstone experience.

The CIT associate degree requirements cover the first half of the bachelor's degree requirements, including the three-course concentration. The Computer Technology associate degree prepares students to complete a bachelor's degree in computer science.

Changes to Current Courses

The introduction of Agile practices and content is broken into two phases divided by a required project management course that students typically take in their second year.

Courses in the first phase use an approach we call stealth Agile, with students using select Agile practices without formally learning the Agile methodology. Courses in this phase cover basic technical skills, including programming, networking, and human computer interaction. We are introducing a variety of Agile practices for the courses in this area. For example, at the end of a content module, students can showcase what they have learned during the module. This can be followed up with a retrospective activity asking students to reflect on their work during the module and consider how they might improve.

Another opportunity for the use of Agile without teaching Agile is in team projects. A consistent set of weekly activities can be used to provide teams with an iterative, learning process similar to an Agile sprint. The instructor can set a goal for each week of the project. At the end of the week, teams showcase their accomplishments, reflect on the team's progress towards the final project goal, and plan improvements. Use of this approach has improved team collaboration and transparency and gives the instructor better insight into each team's progress (Woods & Hulshult, 2018).

Courses in the stealth Agile phase also offer an opportunity to introduce students to technology that is used to support Agile teams. Students are introduced to Trello, which can be used to visually organize and share tasks and Slack, a group communication tool.

An end of the semester activity in the project management course identified additional ideas for using Agile without teaching Agile. Students were asked to offer suggestions on course content that would have helped with earlier CIT courses. Several students suggested that user stories in programming class assignments would have helped them understand why a feature was required, thereby helping them think about how to implement the feature.

Once students have active knowledge of Agile concepts, practices, and methods, the next set of courses will build on this and allow students to gain experience using Agile. Courses in this phase include advanced programming and networking, IT strategy and management, and the capstone courses.

In courses with team projects, beginning of the semester assignments have student teams plan their team's activities and develop a social contract for the team. Teams are expected to develop and prioritize user stories for the work assigned to the teams. They then work in sprints with planning, showcases, and retrospectives. Teams are also expected to use technology to support their work. In addition to the tools they have seen in earlier courses, teams are encouraged to explore and identify tools to address specific team needs.

Students are also encouraged to use Agile practices to manage individual assignments and activities. For example, weekly planning and prioritizing of coursework, tracking tasks using Trello (an Agile storyboard), and periodic reflection.

The CIT capstone courses make use of Agile practices to provide peer support and feedback as students work on individual projects. While capstone projects are individual projects, we see value from showcase activities that provide instructor and peer feedback. These are followed by Agile retrospective and planning activities.

Agile Concentration

All CIT students learn about Agile in the project management course and have the opportunity to practice and develop this knowledge in other courses. For students who wish to explore Agile in more depth, we have added an Agile concentration as an alternative to the existing networking and software development concentrations.

The Agile concentration contains three courses that explore specific aspects of Agile and allow students to earn industry certifications from the International Consortium for Agile (ICAgile). ICAgile is a certification and accreditation body that helps companies build sustainable Agile programs by helping people to think and be Agile. The university is an ICAgile member organization, and this allows us to certify our Agile concentration courses with ICAgile (ICAgile Learning Roadmap, n.d.). This allows our students to earn a different ICAgile certification for each course in the Agile concentration. Students who successfully complete all three Agile concentration courses will graduate with three ICAgile industry certifications.

As part of the university's general education requirements, all students are required to complete a thematic sequence offered outside their major. "A thematic sequence is a series of related courses (usually three) that focus on a theme or subject in a developmental way (Miami University General Bulletin, n.d.)." The CIT Agile concentration has been approved as a thematic sequence. The Agile thematic sequence will offer students from other majors the opportunity to learn about Agile and be prepared to use Agile once they graduate, supporting the growing use of Agile throughout the enterprise (Rigby, Sutherland, & Takeuchi, 2016). Using the same courses for both the concentration and thematic sequence should provide a mix of IT and non-IT majors in the classes. We are seeing significant interest in both the concentration and thematic sequence, and the initial course offering was fully enrolled.

The first course in the concentration is the Agile Launchpad. This course is taught at the 200 level. Students learn and apply Agile values, principles, and practices while working in multi-disciplinary teams to complete a semester long project. Students who successfully complete the course earn the ICAgile Certified Professional designation (ICAgile Learning Roadmap, n.d.). This course is a prerequisite for the other two courses in the concentration.

The second course in the concentration focuses on business value. This course is taught at the 300 (junior) level and stresses value-driven project delivery, the Agile mindset, and key Agile practices designed to emphasize customer value. The course also explores creating successful Agile teams, the environment needed to support Agile teams, and frequent, transparent collaboration between the product development team and the business organization. Students who successfully complete this course earn the ICAgile Agile Product Ownership certification (ICAgile Learning Roadmap, n.d.).

The final course in the concentration explores core components of Agile as a project management approach. Topics covered include leadership, facilitation or coaching, adaptive planning, customer communication, value-driven delivery, working in dynamic and constrained environments, metrics, reporting, and contract management. Students completing the course earn the ICAgile Project Management certification (ICAgile Learning Roadmap, n.d.).

4. SUPPORTING ACTIVITIES

The department is undertaking a number of activities to support the Agile based changes to the CIT curriculum. These include faculty development, developing an Agile mindset in the department, and developing a resource repository. An additional effort is to identify other items needed to support our Agile efforts.

We expect faculty development to be an ongoing challenge. The department currently has three faculty members with significant experience working with and teaching Agile practices. Most of the remaining full-time faculty are in the process of learning about Agile practices and incorporating them into their teaching. However, the department also makes use of part-time and visiting faculty and cannot assume that these instructors will have any Agile knowledge or experience.

To support faculty, we are developing a repository of reference material covering basic Agile practices and methods. We are also collecting simple exercises that can be used to teach and practice Agile methods and plan to develop videos and other training material specific to how Agile is used in the courses in our curriculum.

Our programs consistently attract transfer students, and due to the non-traditional nature of our student population, we have a number of students who are on extended paths to graduation or have even taken a few semesters off. These students may transfer credit for project management or may have taken an older version of our project management course. Either way, they may not have the knowledge and experience with Agile expected in our upper-level courses. To address this, we plan to use material from the resource repository we are developing to build short, self-contained online learning modules that these students can use to fill gaps in their knowledge of Agile.

The Agile mindset is the organizational culture needed for Agile to succeed. It includes attributes like trust, respect, collaboration, commitment to improvement through learning, taking ownership, a willingness to adapt to change, and focusing on delivering value to customers. We believe that for our efforts to teach Agile to succeed, individual faculty members and the whole department must develop an Agile mindset.

To support development of an Agile mindset, we are using Agile practices and methods in the operation of the department. Activities supporting our strategic plan are written as user stories to clearly document the value of each effort. These are prioritized and tracked using a Trello board. In department meetings, we apply the Agile stand up concept for reports from department committees and use the Lean Coffee practice (Lean Coffee, n.d.) to engage everyone in facilitating discussions. We expect this to be an ongoing process.

5. CURRENT STATUS

While faculty members have been working to add Agile to specific courses for several years, work on a coherent, collaborative approach to incorporate Agile in the CIT curriculum only started in the past year with the hiring of a new faculty member with extensive working experience with Agile.

The three faculty members with Agile experience are working to share successful efforts to use Agile in specific courses with the rest of the department while they continue to develop and assess new course activities. As other faculty gain experience with Agile, they update the courses they teach to use Agile methods and practices and assess the results of these efforts to add to the department's growing body of knowledge.

Where there is clear agreement on an activity or practice in a specific course, it is adopted by all faculty teaching the course. This works nicely with the department's current efforts to develop online versions of several courses since the university's approach to online courses involves creating a master course used by all instructors. For example, several courses now use the same Agile based activities to organize course project teams.

Official updates to the curriculum are underway. The Agile concentration for the CIT bachelor's degrees and the associated courses have been approved and added to the curriculum. The Agile thematic sequence was recently approved, and we are now working to make students aware of this opportunity. The Agile Launchpad course is being taught on a regular schedule, and development work on the remaining courses, including the ICAgile accreditation process, is being planned. The first of these

courses will be offered in the Fall 2019 semester.

Another part of our current efforts involves sharing Agile with faculty outside our department and university offices. These efforts have two goals. One is to share our knowledge of Agile and help others explore how it can improve their classes or campus offices. We have worked with colleagues from other departments who are now exploring the use of Agile in teaching English, psychology, marketing, and teacher education. In the corporate world, businesses are seeing the value of using Agile across their organizations (Rigby, Sutherland, & Takeuchi, 2016), so we are involving staff and leaders from campus offices in our Agile efforts. An excellent example of this is the team in the dean's office responsible for external relations and campus event planning. An administrative assistant heard one of the authors speak about Agile at a campus event, and over the past year, the team has worked with the author to adopt a number of Agile practices to improve team communication and collaboration and recently engaged in a year-end retrospective to celebrate their successes and plan improvements in the team's efforts.

As a way to be an Agile department, our faculty are leading initiatives across the campus. Agile faculty in our department are partnering with local businesses to bring projects to our Agile courses. Students work in Agile teams to complete projects. This gives students Agile work experiences and helps local businesses to achieve goals. Two of our faculty led an Agile Faculty Learning Community, which partnered with our Agile Launchpad course to develop a website for the Center for Teaching Excellence. Our department is using Agile to facilitate our department meetings and advance our strategic initiatives. There are about 80 faculty across three campuses who have attended Agile faculty training or who are practicing Agile in their courses. This faculty body is publishing research and scholarship on the results of using Agile in the classroom. One such project is collecting data from an online course that teaches the IT project management lifecycle using Agile and traditional methodologies. After two semesters of collecting data, preliminary results indicate that online students strongly agree that using the Agile practices of using storyboards and user stories improved their online learning experience. Results also indicate that students strongly agree that using Agile to complete online group projects made them work better as a team and helped them produce higher quality work.

Our second goal in sharing Agile with other groups is to develop opportunities for experiential learning in our CIT courses. We feel it is important for students to gain experience using Agile and plan to use client projects in our courses. The use of Agile elsewhere on campus could offer opportunities for course projects and for our students to gain experience in specific Agile roles such as Agile coach and business product owner.

6. NEXT RELEASE

Part of our current efforts involves planning for the next release of our Agile CIT curriculum product. As previously mentioned, this will include development of two newly approved courses in the Agile concentration.

Other efforts include continued faculty development. The faculty involved in the Agile concentration courses are planning to complete several training and certification courses to support these efforts and expand their knowledge of Agile. These efforts will also result in additional material for the department knowledge repository. Other faculty are engaged in efforts to develop and apply their knowledge of Agile.

As part of ongoing efforts to incorporate Agile in existing CIT courses, we plan to review all courses that involve team projects and implement consistent Agile based content and activities for teams including the development of a social contract for the team, initial team planning, tools selection, and regular team retrospectives. A planned update to our introductory technical IT course will allow implementation and assessment of activities for students to showcase what they are learning and reflect on how they can improve the work.

A significant part of the next release will involve assessing our efforts to date. It has been two years since we significantly expanded the Agile content in our project management course, so we are assessing how that prepared students to use Agile in later courses. We also plan to assess the Agile Launchpad course, especially the performance of non-CIT majors, to inform the development efforts for the additional course in the Agile concentration. Students from a number of majors have expressed interest in

these courses, and we want to make sure they will be successful.

7. FUTURE PLANS AND CHALLENGES

Plans over the next year include developing and teaching both of the new courses for the Agile concentration/thematic sequence. We will continue to revise existing courses with the goal of having Agile based activities in all courses. This will also require continued faculty development to ensure that faculty can successfully teach and assess Agile based activities. Faculty development efforts will also support work to develop an Agile mindset in the department.

We will also continue to develop connections with business to learn how they use Agile and help our students find jobs that allow them to use and develop their Agile knowledge.

Our efforts face a number of challenges. The primary one is resources. While efforts to incorporate Agile throughout our curriculum will benefit student learning and job placement, the time available for Agile efforts is limited by current faculty workloads and other important department efforts.

Another challenge is the reality that Agile is not for everyone. Students who insist on taking charge, waiting for someone else to tell them what to do, or want exact specifications may struggle with Agile. While we hope that our teaching will allow students to overcome these constraints, we must ensure that they develop useful skills. Similarly, even though the use of Agile is spreading, organizations will continue to use non-Agile approaches instead of or even alongside Agile, so we must prepare to work in these non-Agile environments.

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Editor's Note:

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Skills, Certifications, or Degrees: What Companies Demand for Entry-level Cybersecurity Jobs

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Abstract

People starting cybersecurity careers have three main avenues for achieving entry-level job qualifications: learning in-demand skills, earning industry certifications, and graduating with a college degree. Though people can pursue skills, certificates, and degrees together, financial and time constraints often make people focus their efforts to what they feel would help them most in their careers. Those seeking careers in information systems are reasonably asking themselves if the cost of a college degree is a worthwhile investment. In this paper, we analyze 11,938 entry-level job postings for cybersecurity jobs on Dice.com to determine required and desired qualifications. The results show that 7,177 (60%) of entry-level cybersecurity jobs require a college degree in a related field. Of those, 2,851 (24% of jobs) prefer a graduate degree. 3,406 (29% of jobs) require a certification. Structured query language (SQL), testing, Java, Excel, Oracle, consulting, and database skills are listed in 16% of jobs. The most popular certifications are "Certified Information Systems Security Professional CISSP" (listed in 4.8% of jobs), "Information Technology Infrastructure Library ITIL" (listed in 3.9% of jobs), "Security+" (listed in 2.9% of jobs), "Project Management Professional PMP" (listed in 2.8% of jobs) and "Information Assurance Technical IAT" (listed in 2.4% of jobs). The selected snapshot data show that college degrees are required for 60% of jobs--evidence that college degrees are still in high demand for the field of cybersecurity. However, employers are also looking for certifications and skills.

Keywords: skills, certifications, college degrees, employment

1. INTRODUCTION

The total cost of graduation with a bachelor's degree from a four-year institution rose from $26,902 ($52,892 inflation adjusted) in 1989 to $104,480 in 2016 (Maldonado, 2018). The cost of education relative to earning power requires that many students incur significant debt to finance their educations. In 2019, borrowers in the United States carry $1.5 trillion in student loan debt (Friedman, 2019).

At the same time, education alternatives have emerged that offer instructional content at low or no cost. Sites like Khan Academy offer free courses, but mainly target K-12 education. Coursera offers a broader selection of courses with different ranges of complexity. For example, the Machine Learning course covers topics such as logistic regression, artificial neural networks, and linear algebra ("Machine Learning," n.d.). The Machine Learning course can be taken for free which allows the student to

access all content except graded assignments, or a $79 fee can be paid which unlocks graded assignments and provides the option to earn a certificate. These massively scalable learning options are constantly adding new courses. Basically, as a potential alternative to the college degree, students can find cheap or free resources to learn skills that are sought in industry. A motivated student can learn online much of what is taught in a college classroom. But the same can be said of public libraries which have also failed to put universities out of business. The university seems to still add value beyond the mere collection and dissemination of ideas and information.

Society has traditionally placed value in college degrees beyond the immediate impact to the student on employment prospects. A major goal of universities is to educate a populace that can responsibly participate in the community discourse, produce leaders, and choose political representation. These high-minded goals in some way contrast the guidance of recent decades that told students they need a college degree so that they can land a good job and make good money. The Great Recession of the late 2000s and early 2010s found some college graduates unemployed or underemployed (Abel, Deitz, & Su, 2014), souring many graduates' opinions on the value of a college degree.

The remainder of this paper will shelve the benefits of a university education for society and for individual growth. Instead, the paper will address how skills, certificates, and degrees help people start their careers in information systems. Following is a literature review that compares skills, certificates and degrees. Then, an analysis of job postings is given to determine what the market demands.

2. LITERATURE REVIEW

In this section we describe how skills, certificates, and degrees help people advance their careers.

Skills

Historically, companies in need of highly skilled labor have demanded college degrees. Recently, companies like Google, Apple, and Oracle have dropped the college degree requirement, instead choosing to emphasize work experience and specific skills (Hill, 2019). Skills are the degree to which employees can perform defined tasks. Employees might have skills in a particular programming language, a database platform, or another knowledge domain.

Skills definitely matter, but a narrow focus on specific skills tends to de-emphasize the need for employees to have well-rounded abilities. Some argue that "the skill-based approach is thus insufficient to identify the competence that will enable [an IT] manager to identify new IT opportunities and behave proactively in regard to IT" (Bassellier, Reich, & Benbasat, 2001, p. 163). Another fear is that as soon as the skill for which an employee was hired is no longer relevant, the employer may terminate employment rather than cross-train. Employers are increasingly reticent to invest in training the current workforce (Cappelli, 2014).

The field of information systems is vast, and skills can be developed in an ever-increasing array of topics. In a survey targeting the 2007-2008 hiring period for information systems jobs, fundamental accounting, finance, and marketing skills were expected, along with communication skills and information systems-specific skills such as software development, the systems development lifecycle, privacy, systems documentation, and problem identification (Janicki, Lenox, Logan, & Woratschek, 2008). An analysis of job postings in 2017 that required an information systems degree found that employers want skills such as teamwork, programming, written and oral communication, networking, database, systems analysis and design, and business (Burns, Gao, Sherman, & Klein, 2018). The results, though a decade apart, are largely consistent in their findings.

Certificates and Certification

Certification can be described as either vendor-neutral or vendor-specific (Randall & Zirkle, 2005). Certificates like the CompTIA Security+ assess competence in a fairly broad body of knowledge that does not focus on any one vendor or technology. The Security+ certificate is gained by taking a multiple-choice exam. The Cisco Certified Network Administrator (CCNA) certification tests networking knowledge and skills with an emphasis on Cisco's hardware and software. Though some knowledge transference to different domains is expected, additional study would be needed to perform well on other vendor platforms.

Some certifications target a single technology, knowledge domain, or course. Microsoft offers certification for its Office products. Amazon offers an AWS Certified Alexa Skills Builder exam that "validates a candidate's ability to build, test, and publish Amazon Alexa skills" ("AWS Certified Alexa Skill Builder - Specialty," n.d., para. 1). The skills proven by these certifications are less

likely to transfer to technology in other information systems domains.

Many information technology certifications do not require college degrees, unlike other disciplines such as accounting and engineering (McKenzie, 2006). Some certifications, however, require work experience in a specific domain. For example, to become a Certified Information Systems Security Professional (CISSP), a candidate must have five years of work experience in information security positions ("CISSP Experience Requirements," n.d.).

There is some concern that common certifications fail to make job-seekers stand out because the number of people certified is so high (Gomillion, 2017). However, common certifications might indicate achievement of an in-demand skill. Certification in Microsoft Excel might be common, but many employers seek these skills (Formby, Medlin, & Ellington, 2017).

In an environment when technology changes rapidly, it is understandable why some might argue for achieving certification in areas that industry currently needs. The 2017 job survey mentioned previously showed that 20% of jobs required or preferred certification (Burns et al., 2018). Certification appears to be increasingly important, but college degrees continue to demonstrate value empirically as described in the next section.

Degrees

College degree earners have increased lifetime earnings of a million dollars over their non-degree earning counterparts (Caruth, 2014). The time it takes a student to graduate has a large impact on the net present value of an education, largely due to delayed earnings (Lobo & Burke-Smalley, 2018). The desire to earn money right away is one reason why some choose to forego college, but the data suggests this is a losing strategy for maximizing lifetime earnings. In a survey of adults without degrees, the majority said that the expense of going back to get a degree was necessary to get ahead in their careers (Silliman & Schleifer, 2018).

The focus of study is as important as the decision to obtain a college degree. Vocational training in technical fields can improve earning power more than Bachelor of Arts degrees in liberal arts and humanities (Kim & Tamborini, 2019).

Despite current trends that emphasize hiring people for skills, people in advanced positions frequently have one or more degrees. Job listings for cybersecurity architects list a graduate degree in 27% of postings, a bachelor's degree in 69% of postings, and only 4% with less than a bachelor's degree ("Cybersecurity Career Pathway," n.d.). It is difficult to predict if the increased focus on skills is a reaction to immediate skills shortages, or if it indicates a long-term trend.

Data suggests that a college degree can only help (and not hinder) long-term career objectives. Sadly, some students have embraced the cliché that "C's get degrees" and think that by merely graduating they will be granted a high-paying job in a rewarding career. This short-sighted view leads some to wonder why they fail to succeed in the job search.

Combinations

A student can learn skills without ever obtaining a certificate or degree. While some employers care only about what employees can do, certificates and degrees are commonly used to filter applicants. Earning a certificate or degree (hopefully) proves that a student has learned skills. Some universities have embedded industry certification in degree programs (e.g., Haga, Moreno, & Segall, 2012; Jovanovic, Bentley, Stein, & Nikakis, 2006). It can be challenging to find textbooks that fully cover certification topics (Al-Rawi, Lansari, & Bouslama, 2005). A student can earn a certificate without a degree and vice versa.

Certifications and degrees "both have value for job seekers and the best solution seems to be some combination of both education and certification" (Gomillion, 2017, p. 72).

Proving Value to Prospective Employers

Job-seekers must signal their qualifications to employers (Spence, 1973). College degrees and certifications are two objective ways to signal qualifications. Accreditation bodies ensure that universities follow best practices and provide some assurance of the value of a degree. Certification centers must also follow strict practices to ensure that certification exams are accurate assessments of candidate skills in part by proctoring exams and requiring photo identification. Skills-based assessments (such as coding interviews) can be used to validate the skills that should be evident by degrees or certificates, or when a candidate lacks any credentials.

In the next section, we seek to measure the benefit of skills, certifications and degrees by

evaluating entry-level cybersecurity job postings.

3. METHODOLOGY

We created a crawler to collect data of entry-level cybersecurity professional jobs from Dice.com which is a popular website for IT jobs. The web crawler searched cybersecurity jobs at Dice.com based on commonly used words for entry-level cybersecurity jobs like "Cybersecurity Analyst" or "Cybersecurity Architect." The crawler collected the 11,938 jobs that were available on Dice.com on June 10, 2019. We collected labeled information for each job post like title, keywords (tags such as analysis, firewall, python, security, and TCP/IP), job location, and the job description.

The following preprocessing steps were applied to prepare the data set for analysis. First, all whitespace (such as new lines and extra spaces), punctuation, and HTML tags were removed. Second, the text was converted to lower case and stop words were removed. Stop words are basically a set of commonly used words in any language like "the," "into," "just," and "keep." By removing the words that are very commonly used in each language, we could focus only on the important words instead, and improve the accuracy of the text processing. Next, we applied lemmatization for all words to reduce inflectional word forms to linguistically valid lemmas.

To extract undergraduate or graduate degree requirements we searched for keywords like "bachelor degree," "master degree," "bsc," "msc," "mba," "doctorate," and "phd." To extract professional certification requirements, we looked up unigram, bi-grams, tri-grams, four-grams, five-grams, and six-grams in the sentence where the keywords "certified," "certification," or "certificate" was listed and got the highest frequency of term occurrence to detect the certifications with the highest demand in the job market like "Information Technology Infrastructure Library ITIL," "Certified Information Security Manager CISM," and "Certified Information Systems Security Professional CISSP." To assess skill requirements, we looked for unigram, bi-grams, tri-grams, four-grams, five-grams, and six-grams in the sentence in job keywords and job description and got the highest frequency of term occurrence to detect the skills with the highest demand in the job market like "Structured Query Language SQL," "Testing," and "SAP."

4. RESULTS

The results show that 60% of entry-level Cybersecurity jobs (7,177 jobs) require a college degree in a related field. 24% of jobs (2,851 jobs) prefer a graduate degree. 29% of jobs (3,406 jobs) prefer or require certifications. 6.6% of jobs preferred certifications without specifying certification names. Other jobs listed specific certifications as required or preferred. The most popular certifications are "Certified Information Systems Security Professional CISSP" (listed in 4.8% of jobs), "Information Technology Infrastructure Library ITIL" (listed in 3.9% of jobs), "Security +" (listed in 2.9% of jobs), "Project Management Professional PMP" (listed in 2.8% of jobs), and "Information Assurance Technical IAT" (listed in 2.4% of jobs).

Job Posting Element	Postings
College degree required	60%
Graduate degree preferred	24%
Prefer or require certification	29%

Table 1: Degrees and Certifications in Entry-level Cybersecurity Job Postings

Certification	Postings
Certified Information Systems Security Professional (CISSP)	4.8%
Information Technology Infrastructure Library (ITIL)	3.9%
Security +	2.9%
Project Management Professional (PMP)	2.8%
Information Assurance Technical (IAT)	2.4%
Certified Information Security Manager (CISM)	1.4%
Cisco Certified Network Associate (CCNA)	1.4%
Certified Information Systems Auditor (CISA)	1.4%

Table 2: Most Frequent Certifications Requested in Entry-level Cybersecurity Job Postings

"Certified Information Security Manager CISM," "Cisco Certified Network Associate CCNA," and "Certified Information Systems Auditor CISA" are each listed in 1.4% of jobs. "Global Information Assurance GIAC" is listed in 1% of jobs. "CISCO Certified Network Professional CCNP," "GIAC Certified Incident Handler GCIH," and "CompTIA Advanced Security Practitioner CASP" certifications are each listed in less than 1% of jobs. The listed certifications are either

related to computer networks and security like "CISSP" and "Security +" or more business oriented like "PMP" and "ITIL".

As for the required or desired skills and qualifications, "Structured Query Language SQL" is listed in 6.3% of jobs, "testing" is listed in 5.4% of jobs. "Excel," "Java,, "Oracle," "consulting," "database," and "hardware" are each listed in 2-2.6% of jobs. "JavaScript", "python," "SAP," and "Linux" are each listed in 1.5-1.6% of jobs.

We studied the geographic location of the cybersecurity jobs and the majority of jobs are offered in the west and east coasts as well as Texas and some southern and Midwest states as shown in figure 1. In figure 1, we filtered out states with less than 100 jobs.

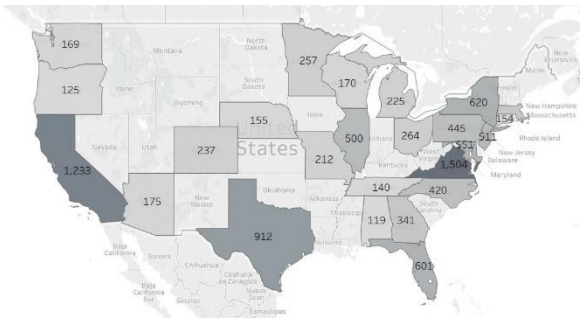

Figure 1. States with High Supply of Entry-level Cybersecurity Jobs

We analyzed the requested or required criteria of having a bachelor degree or certifications in each state with a high supply of cybersecurity jobs. We studied the percentage of cybersecurity jobs that requested or required a bachelor degree or certification to the total jobs per state as shown in Figure 2 and Figure 3 respectively.

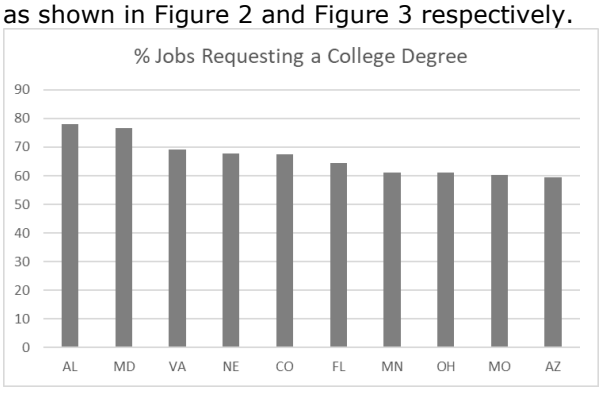

Figure 2. States with the Highest Percentage of Jobs Requiring a Bachelor Degree

There is a high demand for college degree in jobs at all states, and on average 60% of the jobs requested or required a college degree. Figure 2 shows the states with the highest percentage of jobs requesting college degree requirements.

There is a demand for certifications in all states and on average 26% of the jobs requested or required a certification. Figure 3 shows the states with the highest percentage of jobs requesting certifications.

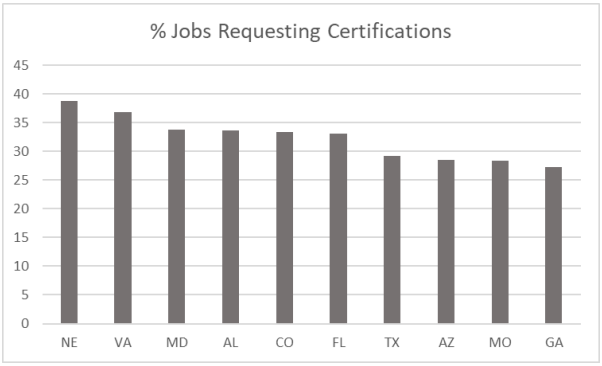

Figure 3. States with the Highest Percentage of Jobs Requesting Certification

5. DISCUSSION

More than half the entry-level cybersecurity jobs require job seekers to have a bachelor degree. Even in entry-level cybersecurity jobs, one in every four job postings has a graduate degree as a preference. Often, employers list jobs with required and desired certifications, but certification requirements are less frequent than college degree requirements. Our results show fewer requirements for college degrees than other sources. For example, the website Cyberseek.org reports high levels of a bachelor degree or higher requirement for entry-level cybersecurity jobs such as technicians and specialists (85%), analyst and investigators (93%), incident responder and analysts (94%), and IT auditors (98%) ("Cybersecurity Career Pathway," n.d.). The difference between our results may be in the distinction between what is preferred versus required.

Also, certification requirements include both business and technical certifications. The collected job posts show high demand for business certifications like "Information Technology Infrastructure Library ITIL" and "Project Management Professional PMP" as well

as high demand for more technical certifications like "Certified Information Systems Security Professional CISSP", "Security +", and "Information Assurance Technical IAT." The CISSP is a popular certification in cybersecurity, and earning the certification requires at least five years of work experience in cybersecurity. We would expect the CISSP to also be a popular certification for mid-level and late-stage jobs.

As shown in figures 1, 2, and 3, the states with high supplies of cybersecurity jobs are not necessarily the states that require a higher percentage of jobs with college degree or certification requirements. States like Nebraska, Alabama, and Colorado do not have the most cybersecurity job postings but are among the states that more often require college degrees or certifications. Also, states like California have many jobs posted but have fewer requirements for degrees and certifications.

There are some limitations on the current analysis that should be noted. First, the search keywords were limited, so it is possible that some job postings or certifications were excluded from the analysis. Second, the current study does not predict the likelihood of a candidate being hired given a set of credentials. We can only assume that if two candidates meet the requirements, the candidates who meet more optional requirements (through either additional skills, certifications, or degrees) will be given preference. The current analysis cannot determine the extent to which an optional college degree will help a candidate gain employment when a degree is not required in the job posting. The extent to which optional qualifications aid in securing a job should be addressed in future research.

6. CONCLUSIONS

Although some might argue that achieving certifications in the industry is becoming more important than earning a college degree to land an entry-level job, this analysis provides empirical evidence that college degrees (bachelor and graduate degrees) are still in high demand for entry-level cybersecurity jobs. However, employers are augmenting requirements and desired qualifications for entry-level work with certifications, skills, and work experience. There is high demand for technical oriented certifications like "Security +" and "CISSP" as well as business-oriented certifications like "ITIL" and "PMP." Accordingly, we recommend that cybersecurity programs at colleges do not overlook the business aspects of the program in favor of the technical aspects or vice versa and aim for balanced programs that cover both aspects. College degrees have more weight than certification requirements, which is reflected in the percentage of jobs with college degree requirements (60%) which is more than twice the percentage of jobs with certification requirements (29%).

As a future extension of this work, we are looking forward to studying the relationship between job requirements (such as college degree and certification requirements) and job benefits (such as salary, flexibility, and location). Also, we look forward to studying jobs in other related IT fields to complement our findings, since in this study we only collected cybersecurity related jobs.

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Looking Ahead to CAE-CD Program Changes

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Abstract

The rising number and cost of cybersecurity attacks justifies continued strong interest in the National Security Agency (NSA) and Department of Homeland Security (DHS) jointly sponsored program for National Centers of Academic Excellence in Cyber Defense (CAE-CD). After briefly outlining the current state of the cybersecurity challenge, this article describes our recent experience in successfully applying for designation as a CAE in 2018 and looks ahead to the considerable program changes in effect with the 2019 CAE-CD application. Those seeking CAE re-designation will be interested to know that there is an estimated 19% increase in required mappings as the previous mandatory Knowledge Units (KU) are replaced with the new foundational + technical core KU path. And, with the creation of a new non-technical path, an institution interested in adding that path will find 35% of the required mapping work will be new.

Keywords: Cybersecurity, Centers of Academic Excellence, CAE, Knowledge Units

1. INTRODUCTION

According to Juniper Research, the cost of cybercrime will exceed $8 trillion globally for the 5-year period 2017-2022 (Moar, 2017). The steady annual increase of criminal incidents and state sponsored hacking are the main drivers of the dramatic increase of the cost estimates. The most high-profile state-sponsored hacking incident to date is related to the 2016 US presidential election (Vincent, 2017). The hackers managed to gain unauthorized access to sensitive data through vulnerability exploitation and quite possibly influenced the election.

In addition, state-mandated digitization of records in most industries (e.g. HIPAA), the growing adoption of the Internet of Things (IoT), and the proliferation of network-capable wearable devices create unforeseen vulnerabilities that are often exposed by hackers. Even though digitization of records offers numerous conveniences (easy sharing of records, reducing costs, etc.), many of the organizations (especially small and medium sized businesses) do not have the capabilities to secure the digitized records beyond the required minimum, and in most cases the baselines are

vaguely implemented leaving the records open for unauthorized access by anyone with even an intermediate grasp of offensive information security knowledge. IoT devices like thermostats or digital cameras are open for exploit unless secured. In 2016 the IoT Mirai Botnet affected huge portions of the Internet, including Netflix and CNN (Kolias, et.al., 2017). In January 2018, it was revealed that the fitness trackers used by US military personnel (though not issued by the US military) were tracking them and creating a vulnerability by uploading the data to a heat map that could disclose classified locations and routes. The vulnerabilities exploited by hackers also significantly increased the number of ransomware cases, such as WannaCry which crippled services within hospitals and other facilities in the United Kingdom, and NotPetya which hindered Ukrainian infrastructure such as the power grid, airports, and public transit (Greenberg, 2018; Newman, 2017).

This growing cost caused by cybercrime leads to an increase in demand for cybersecurity professionals. The Bureau of Labor Statistics reports a 28% growth expectation in information security analysts from 2016 to 2026. The (ISC)2 survey conducted in 2017 states that by 2022 the cybersecurity workforce gap will reach 1.8 million ((ISC)2, 2017). In 2017 more than 350,000 US cybersecurity jobs were unfilled. The Information Systems Audit and Control Association's (ISACA) "State of Cybersecurity: 2019" survey results of 1,020 cybersecurity managers and practitioners from around the globe show that 30% of respondents felt that, on average, less than 50% of applicants to open cybersecurity positions were qualified; while an additional 29% of respondents felt that 3 of every 4 new hires were not qualified.

Nationwide there are several initiatives to alleviate the supply issue. Before the accreditation agencies (e.g. the Accreditation Board for Engineering and Technology (ABET) or the Association to Advance Collegiate Schools of Business (AACSB)) or professional societies (e.g. the Association for Computing Machinery (ACM) or the Institute of Electrical and Electronics Engineers (IEEE)), had the chance to develop curricular guidelines, many higher education institutions had to step up and start offering classes, certificates or undergraduate and/or graduate degrees on cybersecurity topics based on their understanding of the nation's needs. The US government recognizes the potential threat of cyber-attacks on vital components of the country's Supervisory Control and Data Acquisition (SCADA) networks, which are systems performing key functions in providing essential services and commodities (e.g., electricity, water, transportation), and the need for a skilled workforce to combat the risks. Consequently, there has been a substantial effort by the NSA and DHS to support the academic entities building the needed workforce through their CAE designation.

In parallel with the government efforts, the ACM recently released Cybersecurity Curricula (CSEC) 2017 to provide curricular recommendations in cybersecurity education (CSEC 2017). The ACM guidelines were drafted by a Joint Task Force (JTF) on Cybersecurity Education that was comprised of professional and scientific computing groups and/or societies such as the ACM, IEEE Computer Society, Association for Information Systems Special Interest Group on Security (AIS SIGSEC), and the International Federation for Information Processing Technical Committee on Information Security Education (IFIP WG 11.8). The JTF used Computer Science Curricula 2013: Curriculum Guidelines for Undergraduate Degree Programs in Computer Science, Global IT Skills Framework for the Information Age (SFIA), requirements of the NSA/DHS CAE in Cyber Defense and Cyber Operations, Information Technology Curricula 2017: Curriculum Guidelines for Baccalaureate Degree Programs in Information Technology, Guide to the Systems Engineering Body of Knowledge, and US National Initiative for Cybersecurity Education (NICE) Cybersecurity Workforce Framework as the major resources in the development of the guidelines.

While many higher education institutions are in the process of adopting the ACM guidelines that are in agreement with CAE requirements, currently in the US the curricula followed by NSA/DHS CAE-CD designated schools have the benefit of having gone through an objective outside review and, among some recruiters, have added credibility. This article focuses on the CAE-CD related designations and aims to provide insights to educators on what the designation is, what the requirements to get the designation are, and provides some recommendations for prospective applicants.

2. CENTERS OF ACADEMIC EXCELLENCE (CAE) PROGRAM

Brief History

The National Security Telecommunications and Information Systems Security Committee (NSTISSC) was established in 1990 to provide a forum for the discussion of policy issues and to

provide operational guidance for the protection of national security systems (Report of the President, 2001). Among other things, the NSTISSC established training standards that formed the basis for criteria used to evaluate the strength and maturity of educational institutions' information assurance and information systems security (INFOSEC) curricula. In 1998, the NSA created the National INFOSEC Education and Training Program (NIETP) to offer a variety of products and services in IA/INFOSEC education and training, including the sponsorship of the Academic Centers of Academic Excellence in Information Assurance Education (CAE-IAE). After the first round of applications, seven centers in five states were designated in 1999 as CAE-IAE: James Madison University, George Mason University, Idaho State University, Iowa State University, Purdue University, University of California at Davis, and University of Idaho (Bishop & Taylor, 2009). In 2004 the DHS joined on as a sponsoring partner. The CAE in IA Research was added in 2008 and the CAE-2Y, for designating two-year institutions, in 2010.

Centers of Academic Excellence in Cyber Defense (CAE-CD)

NSA sponsors two types of CAE: one in Cyber Defense (CD) and one in Cyber Operations (CO). In this article, we address CAE-CD programs. The NSA/DHS National CAE-CD program has the stated goal, "to reduce vulnerability in our national information infrastructure by promoting higher education and research in cyber defense and producing professionals with cyber defense expertise." CAE-CD designated schools are formally recognized by the US Government as meeting high, objective standards for CD education.

Regionally accredited two-year institutions can apply for designation as a CAE in Cyber Defense Two-Year Education (CAE-2Y). Four-year colleges, graduate-level institutions, and Department of Defense (DoD) schools can apply to be designated as a CAE in Cyber Defense Education (CAE-CDE), a CAE in Cyber Defense Research (CAE-R), or potentially both.

Twenty years after the designation of the first seven CAE-IAE, there are 297 institutions designated (September 2019) as NSA/DHS National CAE-CDE in 48 states [Alaska and Wyoming do not currently have CAE-CD designated institutions.], the District of Columbia, and Puerto Rico listed on the NIETP website ("National IA Education & Training Programs", n.d.). The breakout is: 97, CAE-2Y; 124, CAE-CDE; 28, CAE-R; and 48, both CAE-CDE/CAE-R. This represents about 6.9% of eligible higher education institutions.

Program Requirements

The university mentioned in this paper is serving ~14,500 undergrads and 2,200+ graduate students. The program mapped to the CAE-CDE Knowledge Units (KU) is the BS in Information Technology (IT) with CyberSecurity Minor. The IT program is an interdisciplinary degree offered by the business school and the College of Arts and Sciences. The CAE-CD program description, experience, and recommendations in this section reflect our successful application for accreditation in spring 2018. The next section will highlight noteworthy differences in effect for applicants of CAE-CD designation in 2019 and beyond.

Applying for CAE-CD designation involves meeting two overarching sets of criteria: program requirements and mapping curricula to cyber defense knowledge units (KUs). The NIETP website provides the functionality for creating an institution account and submitting all required information.

There are some minor differences in the details of the program requirements for CAE-2Y and CAE-CDE designation, but the 8 requirement areas are the same. The requirements for both are available on the NIETP website. At a high level, the program requirements are:

0. Letter signed by the Provost or higher that provides official notice of institutional endorsement and intent to participate in the CAE-CD program.
1. Evidence that the CD academic curriculum path has been in existence for at least three years with one year of student granted degrees with path completion.
2. Evidence that the institution fosters student development and assessment in the field of Cyber Defense.
3. "Center" for Cyber Education – proof of an official institution established entity (physical or virtual) serving as the focal point for cyber curriculum and practice.
4. Evidence of sufficient cyber faculty to ensure continuity of the CD program.
5. Evidence that CD is a multidisciplinary practice that is integrated into additional degree programs within the institution.
6. Institution security plan that includes the policies and practices used to protect the information systems infrastructure.
7. Evidence of cyber outreach/collaboration beyond the institution.

Curricula Requirements

In spring 2018, applying for CAE-CDE required successful mapping of an institution's CD curriculum path to all 11 of the two-year core KUs, all 6 of the four-year core KUs, and any 5 of the 51 optional KUs.

The process of mapping institution curricula to KUs first involves identifying institution courses that cover the topics and meet the objectives for the KUs. The NIETP website provides a useful Excel spreadsheet for this purpose. Once courses have been identified, information and meta data for each course intended to be mapped can be entered on the NIETP website. Meta data includes items like course length, current/past enrollment, and course creation date. Information includes items like a syllabus, outline, major topics, major topic descriptions, and objectives.

When all information and meta data for a course intended for mapping is input to the NIETP website, the mapping to relevant KUs can be done. Every KU Topic must be mapped to at least one supporting course's major topics and course objectives. Each KU Outcome must be mapped to applicable course major topics and course objectives, and provided a justification.

For example, here are the details related to the four-year core KU, *Network Defense*:

Definition – The intent of this KU is to teach students the techniques that can be taken to protect a network and communication assets from cyber threats.

Topic(s):

Implementing IDS/IPS
Implementing Firewalls and VPNs
Defense in Depth
Honeypots and Honeynets
Network Monitoring
Network Traffic Analysis
Minimizing Exposure (Attack Surface and Vectors)
Network Access Control (internal and external)
DMZs / Proxy Servers
Network Hardening
Mission Assurance
Network Policy Development and Enforcement
Network Operational Procedures
Network Attacks (e.g., session hijacking, Man-in-the-Middle)

Outcome(s): Students will be able to:

-describe the various concepts in network defense.
-apply their knowledge to implement network defense measures.
-use a network monitoring tool (e.g., WireShark).
-use a network mapping tool (e.g., Nmap).

To map KU Topics, you must identify at least one course, a major topic, and a course objective. We mapped the topic "Network Monitoring" to our course, Network Fundamentals; the major topic, Lesson 3 – Network Protocols and Communications; and the course objective, "Examine the OSI and TCP/IP layers in detail to understand their functions and services."

For KU outcomes, in addition to mapping courses, major topics, and course objectives, there is a justification requirement. For the outcome, "Students will be able to use a network monitoring tool," our justification was: "Students use Wireshark and Packet Tracer to monitor network traffic."

The 11 two-year core KUs and 6 four-year core KUs required to be mapped to institution courses are listed in the left side of table 1 (found in the Appendix), which also provides a listing that shows the required and optional KUs for both spring 2018 (and earlier) and fall 2018 side-by-side for ease of comparison. While there is a fair amount of overlap between the KU sets, those familiar with the previous mapping process will find that there is also a non-trivial amount of change.

In addition to the 17 required KUs, we had to select 5 optional KUs for the program path and chose:

IA Compliance
IA Standards
Independent Study
Network Security Administration
Operating Systems Hardening

Even though our initial efforts mapping institution courses to KUs resulted in 14 courses being considered for the certification path, we determined that the mapping could be done more efficiently with 11 courses. We found that it is common to pare down the number of courses used for mapping. For example, Darabi and Cruz (2015) started with 62 mapped courses and ended up using 20 to have a manageable number of courses as students need to take all path courses to be eligible for recognition at graduation. The full mapping we did is provided in table 2 (found in the Appendix).

3. RECOMMENDATIONS

We started the most recent effort to seek CAE-CDE designation about 6 months before the submission deadline. This was only possible because one of the authors had attempted to pursue designation several years ago, but for several reasons, including lack of support, that first bid fell flat. Applying for designation is not a small undertaking. Schweitzer, et al, (2006) provide an account of an institution that committed to applying for CAE designation 3 years before doing so in order to ensure all requirements could be satisfactorily met. Darabi and Cruz (2015) indicate they worked about 6 months in preparation for applying for re-designation.

In light of our first attempt and our second most recent successful attempt, we have 4 suggestions for those considering seeking CAE designation.

Suggestion 1 – Get buy-in.
You are going to need a letter signed by at least the Provost endorsing the effort, but the point is you will need a lot of support both vertically and horizontally to meet the program requirements and to assemble required evidence that your curriculum covers all necessary KUs. If your leadership from department up through the institution levels are not on board, you are going to have a very difficult time applying for designation. As well, it is worth noting that one of the faculty members working full time on this application was from the business school and the other one was from the college of arts and sciences. This arrangement ensured the curricular requirements of both disciplines involved in offering the interdisciplinary IT degree were represented and addressed.

Suggestion 2 – Do a mapping of courses to KUs early.
Depending on your confidence level of course-to-KU coverage, you may want to do a rough mapping of courses to KUs even before you approach the academic leadership hierarchy for buy-in; this will depend on your particular situation. Once you are committed to seeking designation, you will definitely want to do a thorough mapping of courses to KUs. Use the Excel spreadsheet provided; it is well constructed. This activity will reveal any gaps or excessive overlaps in the courses you intuitively choose for initial mapping. It will also help to identify early those among the faculty to whom you will be going for support while gathering and submitting the required mapping evidence.

Suggestion 3 – Participate in the mentor program.
A key aspect of the CAE-CD program now that did not seem to exist several years ago when we first considered applying for designation is the availability of mentors. While it is likely that differing personalities will cause various mentees' experiences to vary, our personal experience with our assigned mentor was so positive and obviously helpful that taking advantage should be a no-brainer. The CAE designation rate increased from 42% to 92% since the mentorship program was launched in 2016 (Chan et. al. 2017).

Suggestion 4 – Provide primary personnel with sufficient time.
This suggestion ties in with suggestion 1. Whereas with the first attempt, one of the authors tried to apply while conducting "business as usual," the second time around, tow of the authors were given a course release during the spring semester leading up to the application deadline. With the amount of work required, it does not seem likely that the application process could have been completed if the institution leadership had not supported that action.

4. CHANGES TO CAE

Under the new structure, the CAE-CD program types are aligned by degree: Associates, Bachelors, Masters, or Doctoral. The program requirements enumerated earlier are essentially the same, but there are noticeable changes with the KU mapping. For the Associates and Bachelors programs, institutions still need to provide mappings from program path courses to the mandatory (foundational and core) KUs. Masters and Doctoral programs have the choice of either providing a mapping from their program of study to the mandatory KUs or, if foundational and core knowledge are prerequisites for admission to the graduate program, demonstrating that admitted students possess the necessary knowledge. One way this could presumably be accomplished is by stipulating that matriculating students come from a Bachelors program that was CAE designated. All program types must provide a mapping from the optional KUs to the program of study.

Figure 1 (found in the Appendix) is provided in the "CAE-CD 2019 Knowledge Units" document available on the NIETP website. It provides a visual representation of the possible program paths at each degree level and how those paths interact with the Foundational KUs, Technical

Core KUs, Non-Technical Core KUs, and Optional KUs.

Another change with the new structure is that there are now two program paths available for each program type: technical and non-technical. All paths must include the same foundational KUs, but there are now two different five-KU sets representing core knowledge.
The new group of mandatory KUs (Foundational KUs, Technical Core KUs, and Non-Technical Core KUs) derive their topics and outcomes from a mixture of the previous Core 2Y KUs, Core 4Y KUs, Optional KUs, and new items. As a high-level indication of the scope of change, note that the previously required Core 2Y KU, *Basic Data Analysis*, and Core 4Y KU, *Probability and Statistics* have both been removed. As well, the KU *Basic Scripting* and the KU *Programming* have been merged. We provide a summary listing in table 3.

In an effort to provide a sense of the scope of work involved with the change, we indicate the number of objectives and topics, as well as how many are new – meaning those topics or objectives did not previously exist in the KUs (mandatory or optional) prior to fall 2018. For example, Cybersecurity Functions (CSF) shows: [O:5(1), T:17(2)]. This shorthand is meant to convey there are 5 objectives for this KU, 1 of which is new; and there are 17 topics, 2 of which are new. The numbers in parentheses should sum to the number of "new items" indicated. The objectives and topics not identified as "new" were drawn from the old KUs enumerated below the shorthand.

For institutions awarding Associates and Bachelors as currently designated CAE-2Y or CAE-CDE schools, the new KU structure is the same in overall number of KUs (11 for CAE-2Y/Associates and 22 for CAE-CDE/Bachelors); however there are some differences in what KUs are required and in the make-up of some of the new, mandatory KUs. The new foundational + technical core KU path most closely resembles the old 2Y/4Y mandatory KUs. Comparing the outcomes and topics across structures, we found that about 19% of the required mappings are new; meaning, they weren't previously listed as part of the old mandatory KUs.

With the creation of a new non-technical path to CAE designation, there will be some new work for any previously designated CAE to add this track.

Technical Core KUs
Basic Cryptography (BCY): [O:4, T:18(3)] – 3 new items Introduction to Cryptography
Basic Networking (BNW): [O:6(1), T:9] – 1 new item Network Concepts Network Defense
Basic Scripting and Programming (BSP): [O:4, T:13(3)] – 3 new items Basic Scripting Programming
Network Defense (NDF): [O:4(3), T:13] – 3 new items Network Defense
Non-Technical Core KUs
Cyber Threats (CTH): [O:2, T:18(1)] – 1 new item Cyber Threats
Cybersecurity Planning and Management (CPM): [O:12(7), T:9] – 7 new items Cybersecurity Planning and Management (previously optional KU)
Policy, Legal, Ethics, and Compliance (PLE): [O:3, T:10] Policy, Legal, Ethics, and Compliance
Security Program Management (SPM): [O:3, T:17(6)] – 6 new items Security Program Management (previously optional KU) Cybersecurity Planning and Management (previously optional KU) Systems Certification and Accreditation (previously optional KU)
Security Risk Analysis (SRA): [O:5, T:7] Security Risk Analysis (previously optional KU)
Foundational KUs
Cybersecurity Functions (CSF): *[O:5(1), T:17(2)] – 3 new items* *Information Assurance Fundamentals* *Cyber Defense* *Cyber Threats* *Introduction to Cryptography* *Policy, Legal, Ethics, and Compliance*
CyberSecurity Principles (CSP): *[O:5, T:15(2)] – 2 new items* *Fundamental Security Design Principles* *Cyber Defense*
IT Systems Components (ISC): *[O:4(3), T:19(8)] – 11 new items* *IT System Components* *Systems Administration* *Networking Concepts* *Cyber Defense* *Cyber Threats*

Table 3 – enumeration of Foundational, Core Technical and Core Non-technical KUs, and the pre-fall 2018 KUs from which objectives and topics are derived

If a current CAE designated institution seeks designation under the new structure with both

the technical and non-technical path, then about 35% of the mapping work required will be new. Of the 233 combined topics and outcomes in the new mandatory KUs across both paths (technical/non-technical), 42 (18%) are new and 40 (17%) come from previously optional KUs. The old optional KUs (Cybersecurity Planning and Management, Security Program Management, and Security Risk Analysis) included in the new mandatory KUs are no longer available to be chosen as optional.
However, any institution choosing a single path (technical or non-technical) may use any of the required KUs from the non-chosen path as optional KUs.

With the creation of a new non-technical path to CAE designation, there will be some new work for any previously designated CAE to add this track. If a current CAE designated institution seeks designation under the new structure with both the technical and non-technical path, then about 35% of the mapping work required will be new. Of the 233 combined topics and outcomes in the new mandatory KUs across both paths (technical/non-technical), 42 (18%) are new and 40 (17%) come from previously optional KUs. The old optional KUs (Cybersecurity Planning and Management, Security Program Management, and Security Risk Analysis) included in the new mandatory KUs are no longer available to be chosen as optional. However, any institution choosing a single path (technical or non-technical) may use any of the required KUs from the non-chosen path as optional KUs.

5. CONCLUSIONS

With our world becoming more digital every day and with bad actors proliferating in cyberspace, the need to produce professionals with cyber defense expertise will grow for the foreseeable future. The CAE-CD program is a vital part of the process of setting cyber defense curriculum standards and fostering a community of like-minded educational institutions. With a few thousand graduates per year CAE designated schools will probably not eliminate the cybersecurity workforce completely, but will most definitely help with introducing high quality graduates for entry level jobs in the US.

In addition, nationally there are several ongoing high impact programs that address the shortage of cybersecurity professionals, such as National Science Foundation (NSF) grants (capacity building and scholarship for service), regional/national competitions, government-academia-industry partnerships, K-12 outreach programs (e.g. GenCyber), national consortia and collaborations including academia, government, industry, etc. (Chan, et.al. 2017).

We have shared our recent experience applying for CAE-CDE designation in order to inspire and assist others considering doing the same. The analysis of the upcoming changes will assist the higher education institutions seeking designation and scopes the additional work required of schools who will be coming up for re-designation.

6. ACKNOWLEDGEMENTS

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Editor's Note:

This paper was selected for inclusion in the journal as an EDSIGCON 2019 Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2019.

Appendix

Spring 2018 (and earlier)	*Fall 2018 (and beyond)*
Core 2Y KUs	**Foundational CDE KUs**
Basic Data Analysis	Cybersecurity Foundations (CSF)
Basic Scripting	Cybersecurity Principles (CSP)
Cyber Defense	IT Systems Components (ISC)
Cyber Threats	**Core Technical CDE KUs**
Fundamental Security Design Principles	Basic Cryptography (BCY)
Information Assurance Fundamentals	Basic Networking (BNW)
Introduction to Cryptography	Basic Scripting and Programming (BSP)
Information Technology System Components	Network Defense (NDF)
Networking Concepts	Operating Systems Concepts (OSC)
Policy. Legal, Ethics and Compliance	**Core Non-Technical CDE KUs**
Systems Administration	Cyber Threats (CTH)
Core 4Y KUs	Cybersecurity Planning and Management (CPM
Databases	Policy, Legal, Ethics, and Compliance (PLE)
Network Defense	Security Program Management (SPM)
Network Technology and Protocols	Security Risk Analysis (SRA)
Operating Systems Concepts	**Optional KUs (unique to Fall 2018)**
Probability and Statistics	Advanced Algorithms (AAL)
Programming	Basic Cyber Operations (BCO)
Optional KUs (unique to Spring 2018)	Cyber Crime (CCR)
Cybersecurity Planning and Management	Cybersecurity Ethics (CSE)
Overview of Cyber Operations	Databases (DAT)
Security Program Management	Linux System Administration (LSA)
Security Risk Analysis	Network Technology and Protocols (NTP)
	Privacy (PRI)
	Web Application Security (WAS)
	Windows System Administration (WSA)

Optional KUs (common to both)	
Advanced Cryptography (ACR)	Intrusion Detection/Prevention Systems (IDS)
Advanced Network Technology and Protocols (ANT)	Life-Cycle Security (LCS)
Algorithms (ALG)	Low Level Programming (LLP)
Analog Telecommunications (ATC)	Media Forensics (MEF)
Cloud Computing (CCO)	Mobile Technologies (MOT)
Data Administration (DBA)	Network Forensics (NWF)
Data Structures (DST)	Network Security Administration (NSA)
Database Management Systems (DMS)	Operating Systems Hardening (OSH)
Device Forensics (DVF)	Operating Systems Theory (OST)
Digital Communications (DCO)	Penetration Testing (PTT)
Digital Forensics (DFS)	QA/Functional Testing (QAT)
Embedded Systems (EBS)	Radio Frequency Principles (RFP)
Forensic Accounting (FAC)	Secure Programming Practices (SPP)
Formal Methods (FMD)	Software Assurance (SAS)
Fraud Prevention and Management (FPM)	Software Reverse Engineering (SRE)
Hardware Reverse Engineering (HRE)	Software Security Analysis (SSA)
Hardware/Firmware Security (HFS)	Supply Chain Security (SCS)
Host Forensics (HOF)	Systems Certification and Accreditation (SCA)
IA Architectures (IAA)	Systems Programming (SPG)
IA Compliance (IAC)	Systems Security Engineering (SSE)
IA Standards (IAS)	Virtualization Technologies (VTT)
Independent/Directed Study/Research (IDR)	Vulnerability Analysis (VLA)
Industrial Control Systems (ICS)	Wireless Sensor Networks (WSN)
Introduction to Theory of Computation (ITC)	

Table 1 – side-by-side comparison of the required and optional KUs for spring 2018 (and earlier) and fall 2018 (and beyond)

	Fluency in Information Technology	Platform Technologies	Introduction to Computer Science	Professional and Ethical Issues in Computer Science	Management of Database Systems	Business Application Development	Network Fundamentals	Information Security and Assurance	Network System Administration	Ethical Hacking	Introduction to Statistics
Basic Data Analysis											x
Basic Scripting		x	x								
Cyber Defense	x							x	x	x	
Cyber Threats	x							x		x	
Fundamental Security Design Principles							x	x	x	x	
Info Assurance Fundamentals	x							x		x	
Introduction to Cryptography								x		x	
Info Tech System Components	x	x					x	x	x		
Networking Concepts							x	x			
Policy. Legal, Ethics and Compliance	x			x				x		x	
Systems Administration		x					x		x		
Databases	x				x			x		x	
Network Defense							x	x		x	
Network Technology and Protocols							x		x		
Operating Systems Concepts		x							x		
Probability and Statistics											x
Programming	x		x			x					
IA Compliance	x			x				x			
IA Standards	x			x				x			
Independent Study										x	
Network Security Administration							x	x	x	x	
Operating Systems Hardening		x							x	x	

Table 2 – mapping of program courses to mandatory and optional KUs for spring 2018

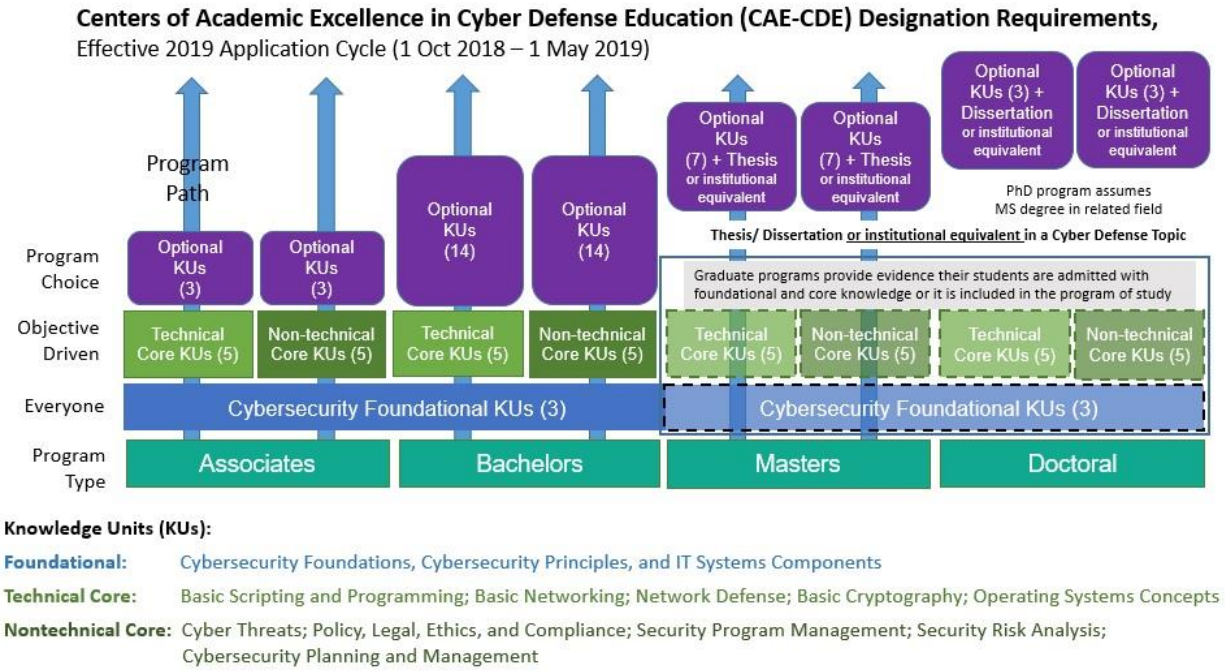

Figure 1 –KU Usage Notional Structure

Evolution of an IS Capstone Class

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Abstract

This paper reviews the evolution of a senior level, live-client project development capstone class in the Analytics and Information Systems department of an AACSB accredited College of Business. The paper traces changes in methodologies and technologies leading to the current Scrum based approach, using ASP.NET Model-View-Controller, MVC, as the development platform. The paper discusses how Scrum is used in a class that only meets three times a week for 55 minutes each time and how the ASP.NET MVC approach to development fits nicely with the Scrum approach to project management.

Keywords: Pedagogy, Capstone Course, Systems Development, Scrum, ASP.Net MVC

1. INTRODUCTION AND EARLY COURSE EVOLUTION

This paper describes the evolution of the capstone project development class in an AACSB accredited College of Business. The story begins more than 30 years ago when the university was on the quarter system and the systems analysis and design portion of the MIS curriculum (then called Computer Systems in Business) was divided into two courses. The first course covered traditional systems analysis topics with an introduction to design issues while the second class continued the discussion of design along with implementation and a little testing. Since there were no easy to use software tools available at the time the project portion of the class was largely based on paper prototypes.

A desire to have hands-on projects that could easily be shared with clients led us to attempt web page development with HTML, but the required overhead made it very difficult to accomplish anything meaningful in less than a quarter. At the time there were no user controls available to speed development and, since HTML was designed to be stateless, there was no easy way to persist data from one session to the next.

In the mid-1990s Microsoft introduced ASP and the first set of ASP user controls. The controls made it much easier for students to develop functional user interfaces but there was still no solution for data in a stateless environment and no easy way to do authentication and authorization. A great deal of class time was spent teaching students how to manage state i.e. read all the data from the request page and write it back to the response page. Additionally, students had to learn some of the early database management tools like open database connectivity (ODBC) or Microsoft's OLE-DB to persist data from one session to another and to create and store user authentication data. Students also had to learn to use cookies and sessions to manage authentication and authorization issues.

In approximately the same time frame we were teaching Cobol (it was the late 1990s), Visual Basic, Java and Mantis, a fourth-generation language. Students complained that they learned tools (Cobol, Java, Mantis) and then never used them for anything else in the curriculum. We also realized that we were spending a lot of time teaching tools and interfaces and not as much time as we wanted on solving business problems and business systems development techniques.

By the end of the 20th century we phased out Cobol and Mantis and replaced Visual Basic and Java with C#. We also decided to use Microsoft's Visual Studio as a common interface in all technical courses so we could focus less on learning new developer interfaces and more on why we were using the tools – to solve business problems. The process was made even easier by the inclusion of enhanced user controls included in releases of ASP.NET, tools that included authentication and authorization that all but eliminated the student's need to spend their limited time trying to implement these functions. The next major change happened in 2008 when the State Board of Regents (2008) issued a report proposing a common academic calendar for all state schools. That report started the process of moving all courses in the department, college and university to semester long courses. In our College of Business it meant that all majors had to restructure and reduce the number of courses offered because 1) much of the curriculum was common to all majors and 2) there was a strong desire to facilitate double and triple majors in the College. For the MIS program the curriculum was reduced to six major courses (systems analysis and design, database, systems development/programming, enterprise systems, a capstone live project development course and a capstone concepts course). The change meant that there was more time to talk about systems analysis and design in the first course but less time to cover programming issues since two quarter length courses were reduced to one semester course. The end result was the need to cover more technical issues in the capstone project development course.

In addition to calendar year-based changes, the department also had an active advisory board that wanted to see more agile development in the curriculum along with more modern development techniques.

2. EVOLUTION OF THE CURRENT COURSE - SCRUM

The author was asked to look at ways to include agile methodology into the capstone development course (Luce, 2016). After much study it was decided to attempt to move the project management portion of the class from a traditional SDLC approach to Scrum because of the wide acceptance of Scrum in industry (Collabnet VersionOne, 2019) and the perceived ease with which course project management could be converted to Scrum

Scrum is an important approach to implementing the goals of the Agile Manifesto and the principles of Agile development derived from the manifesto (Beck, 2001). The Scrum process, scrum team members, scrum events and scrum artifacts are described in *The Scrum Guide* (Schwaber & Sutherland, 2018), Essential Scrum (Rubin, 2013) and numerous other publications.

Scrum starts with a partial list of requirements known as the project backlog items. The work is broken down into a series of timeboxes called Sprints. Each Sprint starts with a planning session where the development team refines the project backlog, prioritizes backlog items, estimates the relative difficulty of each item using relative units sometimes called story points and then moves a group of items to another list called the Sprint backlog which the team then works on during the Sprint. The goal of each Sprint is a potentially deliverable product. Each Sprint ends with a Review of the work with any item that doesn't meet an agreed upon definition of "done" being returned to the project backlog. Each Sprint also ends with a Retrospective where the process is reviewed and modified as needed.

Initial attempts to use Scrum in the classroom were problematic for a number of reasons including 1) students didn't know anything about Scrum and had to learn it before they could use it and 2) we had too many projects, all with clients who were unfamiliar with the approach and weren't able to provide a project owner (one of the required roles in Scrum development) or a workable initial set of project backlog items for consideration by the student teams. Also, while we broke the projects into a series of two or three week sprints, we didn't have a good way to do end-of-sprint reviews or retrospectives and, because the teams only formally met three times a week for a short time, there was no apparent way to do meaningful Daily Scrum stand-up meetings (another required part of the Scrum process).

After two frustrating years attempting to make Scrum work in the course, one of our advisory board members, a former student, said that his company, a midsized consulting firm, would like to work with the department in any way that would be helpful. After some fruitful discussions we decided that they would provide a project for us to use – something they wanted for internal use but couldn't spare the resources to develop. We agreed to have all student teams working on the same project in a friendly competition to see

which team product could produce the best solution. The firm agreed to come down to our campus and launch the project and provide an initial set of project backlog items for the project. They also agreed to try to answer questions from the student teams, to review the work when possible and to come back to campus for final presentations.

This approach worked reasonably well for a year but was still missing important pieces of the Scrum process such as having a product owner, doing a daily Scrum and having a meaningful retrospective at the end of each Sprint. However, our client found benefit in the engagement with us and agreed to make more resources available the next year. They recruited more associates, many were either our former students or graduates of other programs in our university, and had them serve as product owners (POs) for one or two teams each. Each PO was asked to communicate with their teams on a regular basis by whatever remote channel worked best for all of them, to review the team's work at the end of each Sprint and to let the instructor know how the teams were working, both technically and professionally.

3. SCRUM IN THE CLASSROOM TODAY

Students still come to the class knowing little or nothing about Scrum. We spend three or four weeks using readings, videos, quizzes and a few exercises to teach the basic concepts. At the conclusion of the training our client comes to class to present the project charge and provide an initial set of product backlog items. When we first started this collaborative effort the initial set of backlog items provided by the client were fairly specific but in later cycles of the course they became more generalized in an attempt to promote creativity in the solutions.

Each team is assigned a product owner (PO) and a Trello task board containing the initial backlog items. The initial team assignment includes making contact with the product owner and establishing a communication protocol. Teams then work with their PO to understand the initial product backlog, groom the backlog items, attempt to assign priorities and difficulty levels to the items and finally to select items for the initial project Sprint. The deliverable for this task is the updated Trello board.

The next several classes are project work days. In the spirit of true Scrum teams, the student teams self-select roles and start working on the Sprint backlog items. Daily Scrums involve the team talking over the traditional points of this meeting, i.e. what did we do yesterday (since the last class), what are we going to do today and what is inhibiting our progress. Since there are as many as nine teams in the classroom and it is impossible for the Scrum Master (instructor) to attend very many of the Daily Scrum meetings, the teams submit a summarized version of their discussion on the three main questions along with a list of who was in attendance at the meeting. A small number of points that cannot be made up any other way are awarded each day for attending the meeting.

At the end of the Sprint the team publishes the current state of their project, a potentially shippable version of the project, and makes it available to the instructor. Teams meet virtually with their PO to review the work done and post a written summary of the review session, a screen shot of their Trello board at the end of the Sprint and a retrospective discussion for the instructor.

Sprints are primarily graded on following the process and making progress on the Sprint backlog items. Incomplete Sprint backlog items are returned to the project backlog for consideration in the next Sprint cycle. Finally, and very un-Scrum like, team members do a peer evaluation of their team members for the time covered by the Sprint.

The class following the Sprint review is a planning session to start the next Sprint. As before, team members meet with their POs to groom the backlog, re-prioritize backlog items and select the work for the next Sprint. The process continues for three or four Sprints until the end of the semester when the client and typically one or two POs come to campus for final presentations.

Scrum doesn't use traditional planning tools like Gantt Charts of Critical Paths but instead uses a series of timeboxed Sprints. Each Sprint is followed by another Sprint until a releasable product is completed. Progress is typically measured by Velocity, the average number of story points completed per Sprint and Burns Down Charts (Agile Alliance, 2019) showing the completion of backlog items over time.

Instructors interested in investigating Scrum might want to start with the Agile Manifesto (Beck, 2001), *Essential Scrum* (Rubin, 2013) and the professional organizations dedicated to Scrum: Scrum.org and ScrumAlliance.org.

4. PROJECT DEVELOPMENT TOOLS IN THE CURRENT COURSE

Because of changes made in the prerequisite classes, students come to the capstone development class knowing SQL, C# and ASP.Net web forms and have developed web applications using the Visual Studio development environment. These are the tools that were used when the class was first converted to use Scrum. When we first started working with the consulting firm they offered to provide a project template for the teams to use as a starting point for their project development.

When our instruction staff looked at the template we were completely confused. There weren't any web forms in the template and there were lots of other files and folders not normally found in a web forms project. The consultants had given us a ASP.Net MVC project template which neither the instructors nor the students had ever used. Since the semester had already begun and there was no time to learn a completely new approach to web development, the client agreed to go with web forms for another year. During that year we learned about ASP.Net MVC and were ready to launch the revised course the next school year.

5. ASP.NET MVC IN THE CLASSROOM

The current version (Luce, 2017) of the course uses the latest non-Core version of ASP.NET MVC (Microsoft, 10/3/2018) for the development platform. The Model-View-Controller (Tutorialspoint) design pattern, MVC, implements a separation of concerns with program logic in one module (the controller), data in another module (the model) and user-interface in a third (the view). MVC applications use Routing tables (TutorialsTeacher) to establish public paths to applications. A typical path is based on a controller, a method in a controller and possibly optional items such as an ID. For example, the default page of an MVC application is normally the Index method of the Home controller (technically, the Index method returns the View as an ActionResult (TutorialsTeacher) which is sent back to the user). This could be done by entering the full path: **servername.com\home\index**, or just the controller: **servername\home**, or even just the server: **servername\.**

Controllers are implemented as C# class files while views use the Razor view engine (C# Corner, 2018) that combines HTML and C# code and are formatted using Bootstrap (Bootstrap) styles. The model portion of the MVC application uses Entity Framework (Microsoft) to map classes in the application to tables in the database. We initially tried the "database first" approach (Microsoft, 1/14/2019) (entities are created from an existing database) but quickly settled on "code first" approach (Microsoft, 1/21/2019) (entities are defined in classes and a context class that relates them to each other) because it gave students a better understanding of what their data looked like and made database change management easier. Data validation (Tutorialspoint) is accomplished through the use of data annotations.

6. PEDAGOGY FOR USING ASP.NET MVC IN THE CAPSTONE CLASS

As mentioned previously, students come into the capstone class having taken an introduction to systems analysis and design, a database class and a C# programming class. Both the database class and the programming class use Visual Studio Community Edition (Microsoft) and developed pages using web forms. Students have no prior exposure to the MVC design pattern or developing ASP.NET MVC web sites.

Since our major has a very limited number of classes with only one programming class, the programming class needs to focus on fundamentals and doesn't have time to introduce students to ASP.NET MVC. Because of this we developed and use a series of three individual learning activities in the capstone class. We also created instructional documents outlining the required steps to accompany the learning activities. The result of this approach is that students learn new techniques and procedures just-in-time as they use them, much as they will do on-the-job as working developers and analysts.

The first learning activity involves using a standard template to create a default MVC web site for an application of the student's choice. Default web sites have a home page, an about page and a contact page. The home page uses Bootstrap's three column format and is full of links to Microsoft technologies while the contact page has fictitious Microsoft contact information and the about page has a very generic "about us" statement. The learning activities are designed to introduce the students to much of the basic functionality they will need in the client project that follows. The student's first assignment is to 1) modify the home page to display information about their application and eliminate the links to Microsoft pages. They are

free to keep the three-column format or use Bootstrap to modify it to something else. 2) Modify the contact page to be their contact information, or, if they are concerned about privacy, some other fictional, non-Microsoft information and 3) the about page to be about them or whatever organization they have chosen. They are also required to change the navigation bar, which by default contains a link to "ApplicationName", and the copyright information. The navigation bar and the copyright information are both in a shared layout file (similar to a Master page in the web forms world). Finally, they are required to publish the web site to the web college server and submit a link to the published site to show that the assignment is complete.

The second learning activity provides hands-on experience with Entity Framework. Students are asked to pick a simple many-to-many relationship, other than *Order:Product* which was demonstrated in class, and create entity classes for at least three entities along with a context class to link them together. They then create controllers and views for each of the entities and link the new controllers to their home page and navigation bar. As a note, ASP.NET MVC provides easy scaffolding to create a controller and views supporting the full set of CRUD functionality – create, list (read), update and delete. Students are then asked to run the application and add at least four or five records for each entity. Next, students are asked to modify one or more of the models and implement data migration to automatically update the database. Finally, they need to recreate any controllers and views that use the revised model and run the application again.

The final learning activity requires students to become familiar with data annotations, creating dropdown lists and basic Bootstrap formatting. By default, ASP.NET MVC creates all data views using the model's field names but this can be changed through the use of data annotations. For example, a field called **lname** would normally be displayed as "lname" but a data annotation could cause it to be displayed as "Customer last name" instead.

Entity Framework assumes that the primary key of an entity is called **ID** or the name of the class followed by ID, e.g. **customerID**, but this can be changed with the **[Key]** annotation. Some foreign keys are implied by the data but specific foreign keys can also be specified with a data annotation. Data annotations are used to specify required fields, minimum and maximum field lengths, data types and required formats.

When ASP.NET MVC generates a view on the many side of a one-to-many relationship it typically creates a dropdown list to allow the user to select the record on the one side of the relationship. If the primary key of that entity is an integer or GUID, ASP.NET automatically creates a dropdown using data from the next field in the entity on the assumption that no one would reasonably know what the key is. For example, if the record on the one side of the relationship had an integer ID followed by first and last names, the dropdown would list the first name as the display text and have the ID as the value. Since displaying only a single name isn't a useful practice, students are taught how to modify the dropdown list to display the whole name and are required to do that as part of this assignment.

When ASP.NET MVC creates views it creates simple page headers like Index, Edit and Create. While these indicate what the view shows they don't say what entity is involved. Editing these headings to include the entity is another part of this assignment.

Finally, students are asked to add Bootstrap styling to their applications. They are asked to include some of the table formatting options (stripping, hover, boarder, etc.), at least some button styling, several examples of text formatting using wells, alerts, text and background coloring, etc. They are also asked to include at least one dropdown menu on the home page or navigation bar and at least a few of the icons available in Bootstrap 3.

No textbook or trade book is used because none has been found that covers the topics needed for this class. As an alternative to a book, a series of documents have been produced to go along with the three learning assignments and numerous other topics that typically come up during the execution of the client project. Topics included in these documents include:

- Creating your first MVC Application
- Introduction to Views
- Creating data models
- Understanding MCVC Controllers and Scaffolding
- Views with Entity Framework
- Modifying your data model to allow access to names and not just keys

- Linking Microsoft identity Users to application specific user data and restricting access Views
- (and others)

In addition to the documents and learning activities, students are given a set of links to web sites helpful to developers (stackoverflow.com, scrum sites previously listed, Microsoft tutorial and reference sites, w3schools.org, other tutorial sites, etc.) and are encouraged to better use Google to search for information.

7. THE FINAL COURSE STRUCTURE

In its current configuration the course is divided into two distinct parts. The first four to five weeks involves training in Scrum and MVC. Scrum training involves readings, on-line videos, short classroom exercises and daily quizzes. MVC training involves in-class demonstrations, readings and three learning activities.

The remainder of the semester is devoted to the team-based, live-client project. The client comes to class to launch the project and provides an initial set of project backlog items. The project launch is followed by a series of four or five two-week Sprints. Each Sprint starts with a planning session and is followed by four development sessions. The Sprint ends with a review and retrospective session held in conjunction with each team's product owner. At the end of the semester the client returns to campus for final project presentations by each team.

8. COURSE DESIGN STRENGTHS AND WEAKNESSES

At the end of the semester students are given the opportunity to provide feedback on various parts of the course, separate from the university's standard course and instructor evaluation. The following quotes list some of the student feedback received during the most recent course offering.

- The daily scrum did an excellent job of keeping our team on track. It's easy to look to other courses as being priority one when projects are involved. The daily scrum helped ensure we were aware of our project and what needed to be done.
- I'm not exactly sure who the ScrumMaster was in relation to this project
- The frequent meetings with our product owner allowed our team to better understand what needed to be done from a client perspective.
- It was difficult to get negative feedback from our project owner. He would always praise us during our meetings but that was not always reflected in our project.
- The short Sprints allowed our team to better target goals and set sub-accomplishments that reinforced the notion that we were making progress.
- It was hard to simulate scrum in the short class time
- we initially only had 2 people programming which didn't work well so we had everyone try to understand the programming aspects
- R&R's (review and retrospective) were helpful for the team to see what they've done and what they could do better next Sprint.
- The four features of scrum development that worked best for our team were, the daily scrums helping us stay on track, the R&Rs that helped us to plan what we needed to get done, having the Sprint planning days to figure what we did and didn't get done, and lastly the ability to get real time feedback from our product owner.
- I did not realize how heavily involved this course was with an actual client with a meaningful project. I really liked the hands-on nature of this course and it made showing up to class every day a little easier.
- I think prioritizing tasks was one of the most useful things for us. It helped us manage our time.
- It was difficult to set up times with our PO at times. Balancing 4 college students' schedules and a working professional's schedule is not easy. Because it was difficult to get in contact with our PO, we often found ourselves starting on the next Sprint without feedback from the prior Sprint and just assuming the work was satisfactory.
- Our daily Scrums allowed our team to consistently meet and set expectations

9. LESSONS LEARNED

Based on student comments and observations throughout the semester we have learned a number of important lessons about implementing Scrum in the live project based classroom.

1. It takes a lot of time. Having all teams working on the same project helps but students have a lot of questions and need rapid turnaround on assignments.
2. Scrum is difficult to do when you have short classes. We had to allow teams to do their own daily stand up meetings and just provide a written summary.
3. If you are working with an external client or have external product owners helping with the project, it is critical to have a single contact point to help coordinate product owners and deal with any issues that arise.
4. Dedicated product owners are essential but hard to control when you are working with volunteers from outside the university. In addition to the single contact point mentioned above, we have annual meetings to disuses ways to better coordinate and make the feedback better.
5. Establishing regular communication channels and schedules between student teams and their product owner is vital
6. Scrum is a person-to-person approach and doesn't work well with absentee project team members. We have tried different approaches to encourage participation including assigning a small number of points for daily attendance and participating in the daily standup meetings, and peer evolutions that affect individual grades on team deliverables.
7. Students can learn new technical and managerial skills on the fly but it is difficult when they are graduating at the end of the semester and already have jobs.
8. Five or six people cannot work on project code at the same time, especially not in the MVC environment. Some type of source code management is required but we have yet to be successful making this work.
9. Interesting projects that are relevant to the student team members are important. Our projects have largely involved recognizing individuals for their contributions to the organization – something students find relevant. The projects can also have some social network integration and gamifications aspects (leader boards, awards, etc.) and find those aspects interesting.
10. Grading can be difficult. We grade the planning and the daily scrums along with the review and retrospective. Since it isn't a major problem in Scrum if all backlog items aren't complete, they just go back on the backlog, watching how much is done each Sprint is important. Perhaps more important is watching how many backlog items, and which ones, are moved to the Sprint backlog during each planning session. This also feeds back into the first point on timeliness of feedback to students since you don't want them wasting time on items that don't logically belong in the current Sprint.

10. SUMMARY AND CONCLUSIONS

As with courses at other schools, the capstone systems development project class described here has undergone continuous change and improvement over the years driven by changes in technology, changes in accepted business practices and input from our advisory board. The current version of the course, using a live client, Scrum and ASP.NET MVC tools gives students hands-on experience with agile methods and with modern development tools.

The use of Scrum and short Sprints forces students to prioritize tasks that need to be completed and then to focus on a limited set of those tasks at any one time. The implementation of Daily Scrums, while not ideal, allows teams to concentrate on what they have accomplished and what still needs to be done. Reviews and retrospectives at the end of each Sprint allow team members to accurately see how well they completed the work laid out in the Sprint backlog and to look for ways to improve their processes while there is still time for improvements to help. Having product owners who work for the client gives the students first-hand experience working with clients and developing professional communication skills.

ASP.NET MVC works well with agile development and Scrum. Because MVC practices separation of concerns it is easy to update the data model as needed and to independently work on different parts of the project at the same time. The Entity Framework code-first approach and the extensive scaffolding available when creating controllers and views allows students to focus on the client's business needs and not get bogged down in technical details. Also, the full-featured templates provided in Visual Studio make the standing Sprint goal of creating a potentially shippable product, however limited, much easier to accomplish than is possible with traditional web-form development.

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Student attitudes, awareness, and perceptions of personal privacy and cybersecurity in the use of social media: An initial study

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Abstract

This paper describes a study designed to collect student perceptions of personal social media risks and their knowledge of the use of privacy and security settings in social media applications. A paper-based survey was administered to 107 students at a regional campus of a major university in western Pennsylvania, representing 10 classes and 18 different academic majors. The findings suggest that students are aware of privacy and security risks in the use of social media platforms and do value and suggest additional training in this domain. This paper explores a new concept of a maturity model for the instruction of social media risks based on different levels of sophistication from simple account settings to advanced concepts of personal brand management. Future research is suggested in validating the social media, risk awareness and countermeasure maturity model (SMRA-CMM).

Keywords: social media, cybersecurity, privacy, awareness, risk, digital literacy

1. INTRODUCTION

The purpose of the research study was to determine students' attitudes, awareness, and perceptions of personal privacy and cybersecurity of social media sites. Within the context of this study, social media is defined as forms of electronic communication (such as websites for social networking and microblogging) through which users create online communities to share information, ideas or personal messages. Privacy is defined as "freedom from unauthorized intrusion" and the ability to control one's personal information so that only those the owner wishes to view their information are allowed. This includes both control over what information is viewable in social media as well as who can view it. According to Heiten (2016) digital literacy is defined as having three categories that include "1) finding and consuming digital content; 2) creating digital content; and 3) communicating or sharing it" (p.5-6). The authors believe that a fourth category that should be included in the definition of digital literacy is creating awareness of privacy/security risks and countermeasures. To that extent, a paper-based survey was administered to students enrolled in summer classes at a campus of a major university in western Pennsylvania. A paper-based survey was chosen in lieu of administering the survey online to increase the sample size. The three primary research objectives of the study are:

1. To assess student perception regarding social media privacy.
2. To assess whether security matters to college students.

3. To evaluate whether universities should be providing better education regarding cyber-security.

2. LITERATURE REVIEW

The use of social media is prevalent in both the general society and on college campuses. The increasing popularity of the use of social media sites has brought to the forefront a new set of problems and issues facing the 21st century. Today's college generation is facing an emerging risk to reputational harm or financial loss much more so than prior generations since social media is their main form of communication. According to Moallem (2018), "users' understanding of risks and how to protect themselves from cyber-attacks is therefore fundamental in modern life" (p. 80)." According to a study done by the Pew Research Center (2019), 69% of US adults use Facebook and 73% use YouTube. The percentage of users using Instagram, Pinterest, Snapchat, LinkedIn, Twitter, Reddit, and WhatsApp is considerably lower. Among the 18-24-year-old age group 80% use at least one social media site. More specifically 94% use YouTube, 80% use Facebook, 78% use Snapchat, 71% use Instagram, and finally 45% use Twitter. Richardson (2017) in her study reported 90% of the participants were using Facebook and Snapchat and 70% were using Instagram. Most users check their accounts multiple times a day (Pew Research Center, 2019).

Knight-McCord, Cleary, Grant, Herron, Jumbo, Lacey, Livingston, Robinson, Smith, and Emanuel (2016) had conducted a study to determine which social media sites were being used the most by students. They distributed a survey to 363 students both in-person and online. What they found was that like the other studies, Instagram was the most widely used site followed by Snapchat and Facebook. The ones that were not as much used were LinkedIn and Pinterest.

Rivera, Di Gangi, Worrell, Thompson, and Johnston (2015) stated that "…academics must consider how they prepare current and future college students to deal with the personal risks involved in using social media. News coverage has made everyone aware of some of the dangers of revealing personal information through social media, but most news stories sacrifice measured and helpful coverage in the interest of sensational headlines. As a result, it is fair to assume that most social media users have a distorted view of the personal risk associated with using social media" (p. 50). This creates a compelling reason for gaining a deeper understanding of students' attitudes, awareness, and perceptions of personal privacy and cybersecurity in the use of social media sites. Moallem (2018) established the importance of awareness to cybersecurity threats and cited prior studies that found the issue is not with awareness but action.

Sharma, Jain, and Tiwari (2015) found that 84% of students felt that sharing of personal information on social networking sites (SNS) was risky. Moallem (2018) investigated students' cyber security awareness at two California State Universities in Silicon Valley. An online survey was administered to students enrolled in three classes. The survey consisted of ten questions, but none of them focused on social media or privacy. One of the conclusions drawn was that students were "…not very aware of how to protect their data" (p. 86).

Goh, Di Gangi, Rivera, and Worrell (2016) discussed that social media risks can be classified in two areas: social risk and technology risk. They identified social risk to include topics such as cyberbullying, cyberstalking, and identity theft. Technology risk, on the other hand, includes malicious software or malware, hacks, unauthorized access to social media account, and service interruptions.

In summary the studies referenced in this section provided evidence that the use of social media is prevalent in both the general society and on college campuses. The literature further defined a list of commonly used social media platforms and their rate of adoption by different generations of users. The studies did not provide coverage of the topics of security and privacy within the use of social media indicating an opportunity for this research study.

3. METHODOLOGY

The design of the survey was based on the need to identify students' perceptions of cyber-security risk and privacy concerns with the use of social media. Motivating this research was the desire to use the outcomes of the research as input to the development of new curriculum that would be taught at the undergraduate level and would help enhance students' digital literacy and improve the safety of their online behavior.

Upon receiving IRB approval, the authors obtained a list of summer course offerings, from

the campus website, that included information about the summer sessions, instructors, times and locations. Courses that were being taught online were not included. Courses offered in the first and second six weeks sessions along with 12-week sessions were considered. Instructors were contacted via email and asked for permission to come to their classes to administer the paper-based survey. The survey was administered during class time. A paper-based survey was chosen in lieu of an online survey since it would provide the greatest access to students and a larger sample size. During a six-week period, ten classes were visited. The courses represented a variety of disciplines. Only those courses where the instructors agreed were surveyed. The authors visited each class and provided each student with a copy of the recruitment script. If they agreed to participate in the research study, they were provided with a copy of the survey. Students who had already completed the survey in another class, self-reported and opted out of re-taking the survey. Responses were entered into an Excel spreadsheet for analysis. A total of 107 students completed the survey.

Surveys were numbered and closed-ended questions were coded. For the open-ended questions, that required a text response, a consolidation process was used to synthesize the many responses into similar categories. The process began with the authors reviewing all of the responses provided by the students within a specific question. From the responses, common themes emerged and these became the designated "categories" for classification purposes. Each response was re-read and a decision was made as to which category the response belonged in. This allowed for the consolidation of the responses into categories for analysis purposes. The two primary categories of classification were social risk and technical risk.

4. ANALYSIS OF DATA AND FINDINGS

Our findings show that of the 107 respondents, 100 (or 93%) currently use social media while the remaining 7% (7/107) do not. As can be seen in Figure 1, Snapchat and Instagram are the two most widely popular social media platforms in use. Most students used multiple forms of social media. A further breakdown of the responses showed that 23.36% had a single account, 74.76% had multiple accounts, and 1.86% had no accounts. Participants' average age was 21.6 years old, with the youngest being 18 and the oldest 45.

Of the 107 surveys completed, 18 majors were represented. The highest concentration occurred in the following five majors: accounting, biochemistry, biology, business management, education, and psychology. More females (57%) than males (41%) responded to the survey.

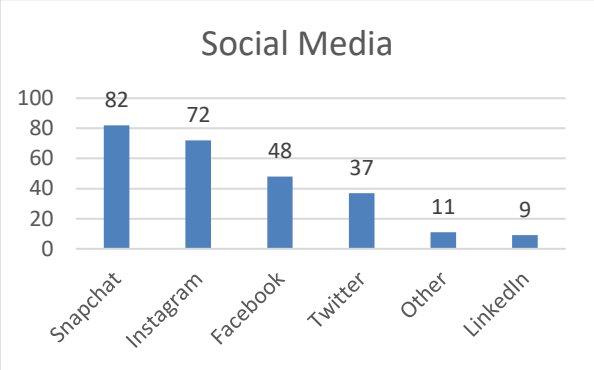

Figure 1. Social Media Use by Platform

Figure 2 below shows the distribution of the student ranks.

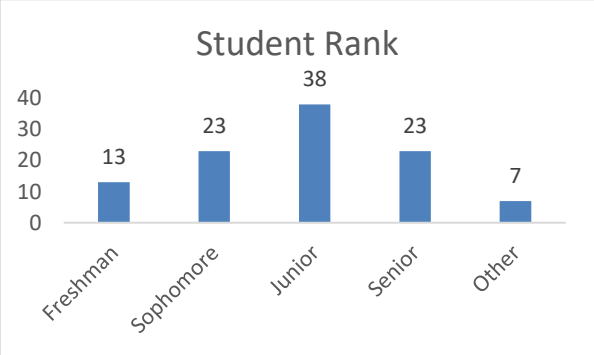

Figure 2. Representation by class rank.

Risk

Social media is a growing platform for student interaction and communication. This research focused on understanding student awareness of risk in the context of cyber security and privacy as it relates to social media. As noted earlier, 93% of the students indicated that they use at least one form of social media. Surprisingly today's digital native has a high level of security awareness with 72.6% understanding the risk of their profile being public and 78.5% knowing how to use the security features available by their social media provider. Participants were asked if they had been a victim of a cybersecurity attack, breach or had experienced a loss of privacy. The majority (71.03%) had

not been a victim. Our survey also showed that students had experienced incidents of both social and technical risk. Of the 30 respondents that had experienced social or technical risk, the majority (90%) had experienced a technical risk. Only 6.67% had experienced a social risk. Naturally, having been victimized the students saw a benefit of setting security features. Interestingly, there were three primary motivations for setting security features to include: risk reduction (31.78%), privacy (30.84%), and control (24.29%). The risk reduction motivation is the act of staying safe from a perceived harm. The privacy motivation is the mechanism to keep their information private. According to common themes found in comments provided for survey question ten, the control motivation implies empowerment over their personal information and acts as a gatekeeper to keep their information safe. Although many would argue that the advantages outweigh disadvantages, the students made three compelling arguments as to why there is a disadvantage to setting security features. These arguments include that security settings limit the full-functionality of the social media application (22.42%), are inconvenient (25.23%), and they are not full-proof (8.41%). However, most students did not see a disadvantage to setting security features (27.10%). See Appendix A for a detailed listing of the descriptive statistics.

Consistent with the high levels of security awareness and sophisticated use of security settings, 50% (or 53/107) of the students cared about knowing the social media privacy policy and did not feel comfortable with their habits being tracked. However, a noteworthy division was noticed in that 52.43% of the students were okay with sacrificing their privacy in exchange for the use of free applications or services and of those comfortable with their habits being tracked, 48.78% saw a direct benefit to being tracked because of targeted advertising. While 24.39% simply saw it as an accepted norm in participating in online activity.

Awareness

Another aspect of our research was to gauge the students' awareness of the importance of using security features. According to question 11 of the survey what we found is that the majority (78.09%) are using security features which corresponds to question four of the survey for which 69% of the respondents stated that their social media accounts are private. This confirms the fact that 84% of the students know how to navigate the social media system settings and set the security options that are available. A combined 80% rated privacy as being very important (48% or 51/107) and important (31% or 33/107) on a 5-point Likert scale.

Education

Our research found that 80% of the students did feel that training should be offered on the concepts of risk to the use of social media and how to use the security settings to mitigate that risk. Our next concern was related to the timing of when that training should be offered. The research found that almost 85% felt training should be offered during the freshman year.

Most students did use the privacy settings in social media to mark their account private. Others wanted to keep their account public because they used their social media accounts for promoting their own small business and felt that security was a negative if it reduced their marketing reach.

Some students create fake accounts/pen names to provide anonymity of their activity on social media to manage their social media presence.

Based on the survey results, students do understand the risk of engaging in unsafe behaviors that compromises their privacy on social media platforms and do know what to do about it. As far as the question related to the need for formalized instruction and its implications on digital literacy in a university setting, the authors were biased in thinking that formalized instruction would be needed and focus on the need to increase awareness of privacy risks in the use of social media and in the use and configuration of security settings.

5. SUMMARY AND CONCLUSIONS

From conducting the study all three research objectives were achieved satisfactorily and the following conclusions emerged:

- Students are aware of the risk of using social media and could provide good examples of issues that have occurred in the past to include account compromise and identity theft.
- A migration is occurring in the use of social media platforms by generation z students. The migration is moving away from Twitter and Facebook to the use of Snapchat and Instagram.
- When security settings were not used the most common reason was that they are hard to understand and use. They

also indicated that it limited their online reach.
- Students do value the need for training on cybersecurity and privacy in the use of social media and feel this should occur in the students' freshman year.

From our research, the authors have formulated a maturity model (see Figure 3) based on a student's sophistication with the use of social media privacy and security behaviors. This model can serve as a guide for future research on the development of training topics and their optimum teaching modality. At the base of the pyramid, setting strong passwords is commonplace amongst the most commonly used social media providers. At the next level, privacy settings include setting an account to be either private or public. At the third level, a secure configuration could include the use of two-factor authentication and geolocation. Fourth is self-regulation, which from the human behavior perspective, determines how one chooses to control their online postings. At the top of the pyramid, the intentional design of the personal brand, otherwise known as their social media presence, is crucial to managing public personal perception such as in the case of hiring or firing decisions and to that extent students must also understand that there is a positive relationship between the use of LinkedIn and obtaining relevant work in their field of study. Richardson (2017) had suggested "social media provides the opportunity for students to create their own persona and branding, whether this is positive or negative. Students can have a true identity, a pseudo identity through social media, and possibly even an anonymous identity as they post and comment. Research that studies the affect that social media has towards forming traditional relationships and identity development would also provide useful information" (p. 94).

The SMRA-CMM is founded on the principles outlined in the NIST Cybersecurity Framework. Specifically is PR.AC-1 which outlines the importance of identities and credentials being properly managed for authorized users (Strong Passwords), PR.DS-5 protection against data leaks are implemented (Privacy Settings), PR.IP-1 a baseline configuration of information systems is created and maintained (Secure Configuration), and PR.AT-1 and PR.AT-2 all users are informed and trained and understand their roles and responsibilities (Self-Regulation of Posting). The concept of self-responsibility defined in PR.AT-1 and PR.AT-2 are further developed in the SMRA-CMM's focus on the end user intentionally crafting their personal brand (what they want others to know and think about themselves online) as this measure of expanded self-responsibility to managing ones privacy and personal security online is consistent with the intent of the NIST Cybersecurity Frameworks section on awareness and training. The elements defined in the NIST Cybersecurity Framework elements are further supported by the SANS Top 20 Critical Security Controls. Specifically, SANS control #3 Secure Configuration, #13 Data Protection, and #17 Security Skills Assessment & Appropriate Training to Fill Gaps. The consistency in guidance for cybersecurity provided by NIST and SANS supports the development of the SMRA-CMM as a model to provide for the basic education of undergraduate students on the necessary elements to protect their privacy and security online while also supports the need for an element of personal responsibility in the self-regulation of their own online behavior once they have implemented the security mechanisms of strong passwords and secure configurations of their social media accounts.

Through this research study a gap was discovered in the knowledge students had related to the importance of self-responsibility in managing their online social media activity. As self-reported by the students through the survey results, 78% had indicated that they were using the security features of their social media platform thus addressing the technological risk however 52% of students indicated they were okay with sacrificing their privacy for the opportunity to use the social media application indicating a need for additional awareness of training that expands from the technical risk but embraces the social risks as well. To this extent a definition of social risk that includes the influence of social media on future employers and job selection will require additional research. For the purposes of the SMRA-CMM the authors suggest that undergraduate education related to the students' risk to the loss of privacy and security online will require curriculum that first establishes the basis of cyber security basics to include the use of strong passwords and the use of a secure profile configuration to mitigate the technical risk and then further develops an understanding of the social risk that requires the regulation of online social media activity.

Our research has made a unique contribution to Information System education by addressing a gap that currently exists in that there is no formal structure to assess and develop privacy/cybersecurity awareness training for

college students. This study proposes a maturity model that will develop students beyond the use of simple security settings to active management of their online identity and personal brand.

Future research should be conducted on changing attitudes of digital natives with regards to their perception of accepted norms and benefits to loss of some privacy. An opportunity within academia lies in helping students understand the importance of reading and understanding the privacy policies of the sites they visit or applications they use. Additionally, a longitudinal study to understand students' perceptions on cyber-security would also prove to be beneficial.

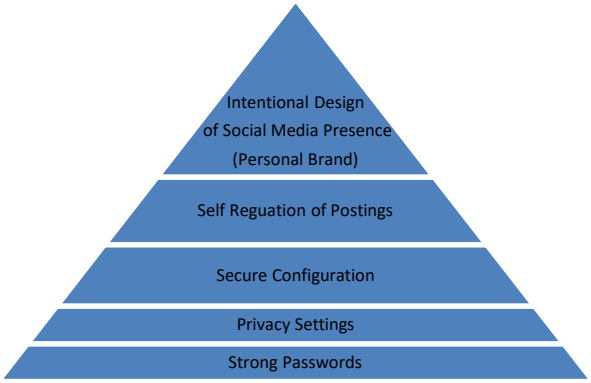

Figure 3. Social Media, Risk Awareness and Countermeasure Maturity Model (SMRA-CMM)

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Appendix A

Descriptive Statistics (N=107)

Item	Frequency	Percentage (%)
Do you use social media?		
Yes	100	93%
No	7	7%
Not applicable	0	0%
Are you aware of security features offered by social media providers?		
Yes	84	79%
No	23	21%
Not applicable	0	0%
What is your current social media account profile status?		
Public	24	22%
Private	70	65%
Don't know	1	1%
Not applicable	6	6%
Both public and private	6	6%
Do you see risk with your social media profile being public?		
Yes	77	72%
No	16	15%
Don't care	6	6%
Not applicable	7	7%
No and not applicable	1	1%
Do you know how to navigate the social media system setting and set the security options that are available?		
Yes	90	84%
No	14	13%
Not applicable	3	3%
Have you been a victim of a cyber-security attack, breach, or loss of privacy?		
Yes	31	29%
No	76	71%
Not applicable	0	0%
On a scale of 1-5 (1- very important, 5 – unimportant), how important is privacy to you?		
Very important	51	48%
Important	33	31%
Moderately important	19	18%
Of little importance	4	4%
Unimportant	0	0%
Are you aware of the privacy policy of how your data is used by social media providers?		
Yes	53	50%
No	49	46%
Not applicable	4	4%
No answer	1	1%
Do you care about how your data is being used by social media providers?		
Yes	59	55%
No	10	9%
Not applicable	3	3%
Haven't given it much thought	34	32%
No answer	1	1%
Is the advantage of having a free social media application greater than the risk of your information being used by the provider or 3rd party as part of "big data analytics"?		
Yes	54	50%
No	36	34%

Not applicable	13	12%
No answer	4	4%
Are you comfortable with having your habits tracked by the social media provider for the purpose of having targeted advertising based on your likes and dislikes or preferences?		
Yes	33	31%
No	71	66%
Not applicable	3	3%
Do you think training should be offered on personal privacy and cyber security awareness?		
Yes	86	80%
No	10	9%
Don't care	11	10%
If you answered yes to the previous question, when should training be offered?		
Freshman	73	68%
Sophomore	7	7%
Junior	3	3%
Senior	0	0%
No answer provided	18	17%
Options 1-4	5	5%
Options 2-3	1	1%

Appendix B

Student attitudes, awareness, and perceptions of personal privacy and cyber security
Student Survey

The survey seeks to gather data for a research study on students' personal privacy and cyber security awareness and its implications on digital literacy.

Cyber-security

1. **Do you use social media?**
   a. Yes
   b. No
   c. Not applicable

2. **What 'brand of social media do you use most frequently? Check all that apply.**
   a. Facebook
   b. Snapchat
   c. Twitter
   d. Instagram
   e. LinkedIn
   f. Other: please specify _____

3. **Are you aware of security features offered by social media providers?**
   a. Yes
   b. No
   c. Not applicable

4. **What is your current social media account profile status?**
   a. Public
   b. Private
   c. Don't know
   d. Not applicable

5. **Do you see a risk with your social media profile being public?**
   a. Yes
   b. No
   c. Don't care
   d. Not applicable

6. **Do you know how to navigate the social media system setting and set the security options that are available?**
   a. Yes
   b. No
   c. Not applicable

7. **Have you been a victim of a cyber security attack, breach, or loss of privacy?**
   a. Yes
   b. No
   c. Not applicable

8. **If you answered yes to #7, please provide any details of the incident that you would be willing to share.**

9. **What do you see as the benefit of setting security features?**

10. What do you see as a disadvantage of setting security features?

11. Are you using the security features? Please explain.

Privacy

12. On a scale of 1-5 (1 – very important, 5 - unimportant), how important is privacy to you?
1. Very important
2. Important
3. Moderately important
4. Of little importance
5. Unimportant

13. Are you aware of the privacy policy of how your data is used by social media providers?
a. Yes
b. No
c. Not applicable

14. Do you care about how your data is being used by social media providers?
a. Yes
b. No
c. Not applicable
d. Haven't given it much thought

15. Is the advantage of having a free social media application greater than the risk of your information being used by the provider or a 3rd party as part of "big data analytics"?
a. Yes
b. No
c. Not applicable

16. Are you comfortable with having your habits tracked by the social media provider for the purpose of having targeted advertising based on your likes and dislikes or preferences?
a. Yes
b. No
c. Not applicable

17. If you answered Yes to #16, why are you willing to give up your privacy?

18. Do you think training should be offered on personal privacy and cyber security awareness?
a. Yes
b. No
c. Don't care

19. If you answered yes to #18, when should training be offered?
a. Freshman
b. Sophomore
c. Junior
d. Senior

Demographics

20. What is your age? _____

21. What is your major? _____

22. What is your level?
- a. Freshman
- b. Sophomore
- c. Junior
- d. Senior
- e. Other: _____

23. To which gender identity do you most identify?
- a. Male
- b. Female
- c. Transgender female
- d. Transgender male
- e. Gender variant/non-conforming
- f. Not listed _____
- g. Prefer not to answer