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INFORMATION SYSTEMS EDUCATION JOURNAL

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Connecting the Dots: Strategies to Recruit Computer Information Systems Students

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Abstract

Business school students in Computer Information Systems (CIS) majors are empowered to meet the demands of Information Technology with both technical skills and business expertise. Competition from other college majors makes recruiting CIS majors in business schools challenging. This research improves the effectiveness of CIS recruitment programs by utilizing multinomial logistic regression (MNL) methodology. Data from an online survey with 145 respondents was analyzed to explore the factors that influence a student's choice of major, when the student chooses a major, and when a career field is chosen. Guided by Theory of Planned Behavior, the results of this research suggest that student's attitude, subjective norms, and perceived behavioral control each influence the choice of major, and when the college major and career field are chosen. Effective CIS recruitment strategies are developed and presented based on the insights obtained from this study. Limitations and future research are also provided.

Keywords: Computer Information Systems, CIS Recruitment, College Major, Pedagogical Research, STEM Education, Theory of Planned Behavior.

1. INTRODUCTION

The number of students who major in Information Systems (IS) has been cyclical since its inception as a college major in the mid-1970s. Businesses started to appreciate the importance of information systems when the ethernet was introduced in 1973, which resulted in more students majoring in IS. Strong enrollments in IS degrees was also seen in the mid to late 1990s as the emergence of the internet and B2C e-commerce services gained traction. The NSDAQ Composite index spiked in the late 1990s when many investors invested in any company that resembled a dot-com company. This resulted in a need for IS/IT talent. Interest in IT related majors peaked and then sharply declined in 2000-2002 time period when the dot-com bubble burst. A similar pattern was observed when the financial crisis of 2007-2008 occurred. After the dot-com bubble burst and the global financial crisis occurred, IT opportunities tanked, thus students majoring in IS/IT declined. In several instances universities have even eliminated their IS/IT degree programs.

More recently, emerging technologies like cloud computing, blockchain, artificial intelligence, and machine learning have started to change the dynamics and business activities of organizations and individuals once again (Panetta, 2017). Attracting students to Science, Technology, Engineering and Math (STEM) fields has never been more important. However, possessing only

technical skills is not sufficient. Business and management skills are also necessary, suggesting that the adoption and implementation of innovative information and communication technologies require both technical and business expertise. Computer Information Systems (CIS) students distinguish themselves by having strong communication, analytical, critical thinking skills, and leadership and collaboration skills (Mandviwalla, Harold, Pavlou, & Petrucci, 2017). Parks, Ceccucci, and McCarthy (2018) suggest that analytical skills, information technology (IT) skills, and communication skills are expected from new graduates. Therefore, Information Systems (IS), Computer Information Systems (CIS), and Management Information Systems (MIS) majors from business schools are ideal employment candidates for the 21st century since they have technology and business skills. While there are other college majors that compete with CIS students in the IT field, such as Computer Science and Computer Engineering, CIS majors bring valuable knowledge from multiple perspectives to the IT related job market.

Even though salaries are high and career opportunities are abundant, attracting CIS majors is a challenge for business schools and filling open IT positions with applicants that have technology and business knowledge is worrisome for employers. Based on the Information Systems Job Index report published in 2017 the salaries for CIS majors are significantly higher than other typical business majors. In a survey of 2,140 respondents in the United States, the average salary for employees with a CIS bachelor's degree is $62,820, while CIS master degree employees average $72,517 (Mandviwalla et al., 2017). In the United States, it is estimated that there are about 3 million available CIS and IS jobs. However, there are less than 1,300 IS related programs offered in business schools.

For many prospective and current college students, CIS job opportunities, career paths, and necessary IT skills are poorly understood. The CIS major and labor market are obscured by computer science and computer engineering majors and employment opportunities, thus the CIS major and CIS field face shortages of students and job applicants. If business schools are to effectively recruit CIS majors, it is wise not only to understand what factors influence the choice of CIS and other business majors, it is sensible to understand when students decide on their college major and when they decide on their career field.

If CIS departments are to attract students to CIS and grow the CIS major and to understand where the next generation of CIS talent will come from, it is imperative to identify the factors that influence a student's choice of CIS as a major and what influences students to choose other business majors. Moreover, it is also important to understand the timing of when students make their college major decision and when they decide upon their career, which are often overlooked. While there is a considerable number of students who choose to study business, few of them choose or are even aware of CIS and related majors. Therefore, this research intends to provide guidance to recruit CIS majors by answering the following research questions:

RQ1. What factors influence a student's choice of CIS as a major compared to other business majors?

RQ2. What factors influence when a student chooses a college major?

RQ3. What factors influence when a career field is decided?

Next, a literature review and theoretical framework follows. Then, the research methodology is discussed, along with the analysis and results. The paper concludes with a CIS recruitment strategy and conclusion sections.

2. LITERATURE REVIEW

The literature review examines previous studies related to college major choice, the timing of the college major selection, and when a career field is decided. It is interesting to note that many studies have been conducted surrounding the reasons why students choose college majors, though few have been conducted related to CIS. Further, research in the areas of when a major is chosen or when a career field is decided upon is nearly non-existent, especially in the area of CIS.

There are a number of reasons that affect whether or not students choose CIS as a college major. Interest has been identified as a key element to selecting CIS/MIS as a major (Ferratt, Hall, Prasad, & Wynn, 2010). Hodges and Corley (2016) examined gender in their study and discovered that personal image and genuine interest influence when females decide whether to choose a CIS major. Jung, Clark, Patterson, and Pence (2017) argue that viewing technology majors as "smart/intelligent" and "nerdy" may prevent female students from selecting CIS as a major. Positive attitude towards IT has also been

strongly associated with selecting IT related majors (Heinze & Hu, 2009). Turner, Bernt, and Pecora (2002) identified that social and familial influences have very strong impact on women choosing IT related majors. Further, Downey, McGaughey, and Roach (2011) suggest that the social and personal image of a CIS career, the major workload, and influences from family, friends, peer students, and professors are major reasons that business students do not select the CIS major. In addition, Walstrom, Schambach, Jones, and Crampton (2008) found that students did not select CIS as a major because it is "not what I wanted to do" and the "subject is not of interest." Additionally, Zhang (2007) found that gender, interest, family, and professors were influential in selecting an IS major. Last, students who choose CIS majors tend to have a strong interest in linking business with technology (Ferratt et al., 2010).

Previous research in non-CIS major selection studies has identified a number of influential factors. These factors include, interest in the subject matter (Noble Calkins & Welki, 2006), subjective beliefs, personal tastes, and potential earnings (Wiswall & Zafar, 2014), early grade performance in college (Stinebrickner & Stinebrickner, 2011) and interest in the related career field (Leon and Uddin, 2016), and perceived social image (Kumar & Kumar, 2013; Ma, 2011).

While there are many studies that evaluate the factors that influence students' choice of college major, studies that assess the timing of this choice are limited. Very few studies fully discuss the importance of the timing of the decision and its implications for student recruitment. Most of the research that examines the timing of the college major decision is in the accounting field and these studies are inconclusive. Some research indicate that major selection is made prior to entering college and others indicate that this decision is made in the first or second year of college (Hermanson, Hermanson, & Ivancevich, 1995; Jackman & Hollingworth, 2005; Karnes, King, & Hahn, 1997; Mauldin, Crain, & Mounce, 2000). Interestingly, Kugler, Tinsley, and Ukhaneva (2017) report that female students are more likely to switch out of STEM related majors due to lack of fit with the major, low grades, and external stereotyping signals. A survey of high school students suggested that students tend to select their majors early (Granitz, Chen, & Kohli, 2014).
Knowing when students are likely to decide on a vocation or career and what influences this decision is essential for student recruitment. To date, there does not appear to be any research in this area in the CIS field. Interest however, has been linked to education and career choices. Vocational interest is "interest in a particular field of education or employment" (Leon & Uddin, 2016) and is a central predictor in choosing a college major, particularly a STEM major like CIS (Akbulut & Looney, 2007). From an embeddedness perspective, interest plays a critical role in the selection of technology related majors (Dabney, Johnson, Sonnert, & Sadler, 2017; Morganson, Major, Streets, Litano, & Myers, 2015). Similar to college major decision, vocational interest may emerge across a wide age spectrum (Maltese, Melki, & Wiebke, 2014).

3. THEORETICAL FOUNDATION

Previous CIS major studies have routinely used Theory of Reasoned Action (TRA) as the theoretical framework (Downey et al., 2011; Hodges & Corley, 2016; Kuechler, McLeod, & Simkin, 2009; Zhang, 2007). This research utilizes Theory of Planned Behavior (TPB) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), which is an extension of TRA. TPB was chosen because of its multidimensional view and because TPB has had a major impact on extending theory in choice and decision-making behaviors (Leon & Uddin, 2016; Prislin & Crano, 2008). As a widely utilized theory in the psychology and information systems, TPB focuses on understanding the relationship between attitude toward behavior, subjective norms, and perceived behavioral control with intention and the actual behavior. Attitude toward behavior means individuals have a favorable or unfavorable reflection of the behavior of interest. Subjective norm is a social factor that reflects the extent to which a person perceives social pressures from significant others to perform or not to perform a behavior. Perceived behavioral control refers to individuals' perception of ease or difficulty in conducting the behavior of interest. It is suggested that the more favorable the attitude and the subjective norm, and the greater the perceived behavioral control, the higher the likelihood that the intention and behavior will be acted upon (Ajzen, 1991, 2002).

Given the literature review and theoretical framework, this paper contributes in several ways. First, this study expands upon the CIS major selection research. Second, this paper analyzes when CIS and other business majors are selected and when the career field is selected. The timing of CIS major selection and interest in the field have not been previously studied. These insights will provide crucial information for effective CIS recruiting efforts by university CIS

departments. Third, this study uses TPB as its theoretical foundation, rather than TRA. By doing so, we include perceived behavioral control into the model and therefore allowing for increased generalizability of the results for CIS college major selection studies. Last, recruiting guidelines are for CIS majors are presented.

Research Model and Hypotheses

The conceptual research model (Figure 1) is developed from the literature review and TPB. It shows that this research intends to answer the research questions from the following hypotheses:

RQ1. What factors influence a student's choice of CIS as a major compared to other business majors?

H1a. A student's attitude toward a major will directly influence the choice of major.

H1b. Subjective norms will directly influence a student's choice of major.

H1c. A student's perceived ability to perform in the major will directly influence the choice of major.

RQ2. What factors influence when a student chooses a college major?

H2a. A student's attitude toward a major will influence when the student decides upon the major.

H2b. Subjective norms will influence when a student chooses the major.

H2c. A student's perceived ability to perform in the major will influence when the choice of major is made.

RQ3. What factors influence when a career field is decided upon?

H3a. A student's attitude toward a career field will influence when interest in the career field begins.

H3b. Subjective norms will influence when interest in the career field begins.

H3c. A student's perceived ability to perform in the career field will influence when the choice of career field is made.

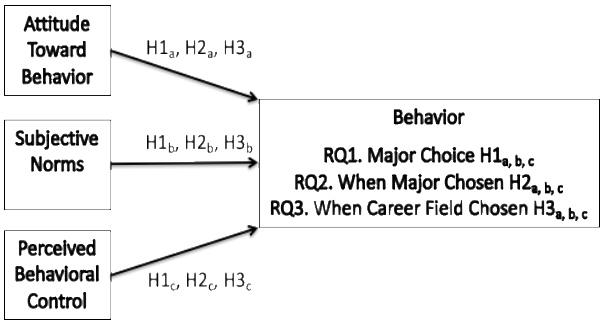

Figure 1 Research model

4. RESEARCH METHODOLOGY

Data Collection Instrument

An online survey was created using the TPB framework and survey items from previous studies (Hodges & Corley, 2016; Leon & Uddin, 2016; Zhang, 2007). The categorical variables used in the analysis along with their overall significance are presented in Table I in the appendix. *Major Choice*, *When Major Chosen*, and *When Career Field Chosen* are the dependent variables for each of the multinomial logistic regression (MNL) regressions. Computer Information Systems (CIS) is the reference category for the Major Choice model. Thus, a comparison is made between CIS majors and four other college major groups. One group includes accounting, finance and banking, risk management, insurance, and economics majors. A second group includes management majors (management, international business, and hospitality and tourism). The two remaining groups include marketing majors and supply chain management majors.

The variables and constructs selected for this study are presented in Tables 1 and 2 in the appendix. Several variables in this research fall into one or more constructs. Gender could be applied to attitude toward behavior and/or subjective norms. In some cultures, it is not expected or acceptable for women to conduct certain jobs or occupations. Influenced by Prior Experience in the Field could be applied to both attitudes toward behavior and/or perceived behavioral control. Prior experience can influence a student's attitude toward a particular major or subject area and after experiencing a subject area, a student is either reassured that they possess the skills to continue in the major or career field. The explanation for Extracurricular Activities is similar to that of Influenced by Prior Experience in the Field. In addition, since Extracurricular Activities by their very nature are

group activities, social norms is likely to affect behavior.

Among the variables in Table I in the appendix, respondents were asked to select "all that apply" regarding awards students received in high school, which extracurricular activities they participated in during their high school years, and who influenced or will influence them the most in choosing their college major.

The metric variables that were included in the analysis and overall significance are described in Table II in the appendix. The research study asked respondents nine influence measures. Respondents were asked using a 7-point Likert scale (1 = Definitely Not Influential, 7 = Very Influential): "What influenced you or will influence you to choose a college major?" They were also asked to what extent they agree with the following statement using a 7-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree): In high school I considered myself proficient in math.

Data Collection Process

An online survey was administered to students in several undergraduate and graduate classes from a southeast United States public university in the spring 2018 semester. The survey was available to 191 students in six sections who represented a variety of college majors. The survey returned 145 total responses (75.9 percent response rate). Students were enticed to complete the survey by offering extra credit. Four responses were incomplete, and 10 responses were from non-business majors. Therefore, these 14 responses were excluded from the analysis. Thus, the net response rate for the survey was 68.6 percent. Furthermore, 14 respondents were undecided about their career field, accordingly, these 14 responses were excluded from the *when career field chosen* analysis.

5. ANALYSIS AND RESULTS

This section discusses the results and the research questions. This research seeks to understand the factors that influence selecting a particular major, knowing when a particular major will be chosen, and knowing when a career field was chosen. Thus, multinomial logistic regression (MNL) is employed, which is appropriate when dependent variables are nominal categorical.

The nine (9) survey items related to, "what influenced you or will influence you to choose a major" show good reliability with a Cronbach's alpha reliability coefficient of 0.753 (Nunnally, 1978). Additionally, each of the three MNL models fit well. When covariates are added to the models, each model's - 2 Log Likelihood and Nagelkerke pseudo R-squares improve. When testing the global null hypothesis, the likelihood ratio tests (Tables III, V, VII in the appendix) are significant, concluding that the models with predictors are a better fit than without predictors. The tables contain a column labeled Reciprocal of Odds Ratio showing the reciprocal of the Odds Ratio when the Odds Ratio is less than one. By doing so, the prominent variables stand out, providing a more intuitive and clear meaning of the results with less room for misinterpretation.

College Major Choice

The first research question, "What factors influence a student's choice of CIS as a major compared to other business majors?" is addressed in this section. The results in Table III in the appendix indicate that Gender, Who Influenced, HS Math Proficiency, High Starting Salary, Prestige, Positive Career Outlook, Prior Experience, and Father's Career Level are significant factors influencing a student's major choice.

The findings support each of the hypotheses. Gender, Influence from High Starting Salary, Prestige, Positive Career Outlook, and Prior Experience in the Field support H1a. Gender, Who Influenced, and Father's Career Level support H1b while Prior Experience and HS Math Proficient support H1c.

The odds of male students choosing CIS over Accounting/Finance is 8.475 times, Management is 4.237 times, and Marketing is 14.286 times than that of female students. Advisors influence CIS majors to a greater degree than Accounting/Finance and Marketing majors and, Relatives influence CIS majors to a greater degree than Supply Chain Management majors. Students who see themselves as proficient in math tend to choose CIS over Management. A one-unit increase in a student's response on HS Math Proficiency will increase the odds of choosing CIS over Management by approximately 34 percent (odds ratio = 1.339). Students who are influenced by High Starting Salary tend to choose CIS over Management and Marketing. A one-unit increase in a student's response on High Starting Salary will increase the odds of choosing CIS over Management by approximately 158 percent (odds ratio = 2.577) and CIS over Marketing by approximately 343 percent (odds ratio = 4.425). On the Prior Experience scale, there is a significant difference between CIS and

the other four major categories. As the score on the Prior Experience scale increases, the odds of choosing CIS increase compared to that of Accounting/Finance, Management, Marketing, and Supply Chain Management.

When Major is Chosen

The second research question, "What factors influence when a student chooses a college major?" is addressed in this section. Table IV in the appendix shows when students decide on a major by discipline. This research supports previous research, which suggests that most students select their major before their junior year. This may be attributed to students typically would start their college major classes in their junior year. Additionally, this study found that there is a large contingent of CIS majors who chose their major prior to university study.

Table V in the appendix shows Who Influenced, Extracurricular Activities, and Awards in High School are significant factors in deciding when a major is selected.

The findings support the hypotheses. Extracurricular Activities supports H2a, Extracurricular Activities and Who Influenced support H2b, and HS Award Received supports H2c.

Students who are influenced to choose a major by a Relative tended to choose their major Before College. When Mothers or Advisors influenced the student's choice, the student was more likely to choose their major in their Junior/Senior Year. Students who participated in Student Government in High School were more likely to choose their major Before College followed by choosing their major in their Freshman/Sophomore Year. Students who participated in Academic or Service Clubs in High School were more likely to choose their major in their Junior/Senior Year. Students who won an award for high Grades or placed on the Honor Roll were more likely to choose their major in their Freshman/Sophomore Year.

When Career Field Chosen

The third research question, "What factors influence when a career field is decided?" is addressed in this section. Table VI in the appendix shows that 42 percent of CIS majors become interested in their career field prior to beginning their college studies.

Table VII in the appendix indicates that Math Proficiency, Who Influenced, Extracurricular Activities, and Prior Experience in the Field are significant factors that influence when a career field is chosen.

The findings support each of the hypotheses. Extracurricular Activities and Influenced by Prior Experience in the Field support H3a, Who Influenced and Extracurricular Activities support H3b, and Extracurricular Activities, Math Proficiency and Prior Experience in the Field supports H3c.

The odds of deciding on a career field Before College over the Junior/Senior YR by those influenced by Advisors is 5.864 times than those who have not been influenced by Advisors. The odds of deciding on a career field in the Freshman/Sophomore YR over the Junior/Senior YR by those influenced by Mothers is 2.545 times than those who have not been influenced by Mothers. The odds of deciding on a career field in the Junior/Senior YR over the Before College category by those who entered a Technical Skills Competition is 5.556 times than those who have not entered a Technical Skills Competition.

As the score on the Math Proficiency scale increases by one unit, the odds of deciding on a career field being established in the Junior/Senior YR increases by 31 percent (odds ratio = 1.305) compared to that of the Freshman/Sophomore YR. As the score on the Prior Experience scale increases by one unit, the odds of deciding on a career field being established Before College increases by 45 percent (odds ratio = 1.450) compared to that of the Junior/Senior YR.

CIS Career Insights

Additional insights for recruiting CIS majors were achieved by asking 101 non-CIS majors from the sample, supplementary questions related to the CIS career field. The survey asked students why they were not pursuing a CIS career and overwhelmingly, 65.3 percent of the students said they were not interested in the CIS field, and 18.8 percent answered that they did not feel they were capable of performing well in this field. Other responses by students included that they have other interests and are steadfast on another career field. Interestingly, none of the students answered that salaries in the CIS field were not high enough. Next, these students were asked, what do you think would help persuade you to choose a CIS career? Fifty percent of the students responded by saying that being previously exposed to the field would have helped, followed by an information session (22%), job security (10%), and job growth (10%).

In addition to the previous questions, non-CIS major students were asked to what extent they agree with the following three statements using a 7-point Likert scale (1 = Strongly Disagree, 7 = Strongly Agree):

1. I heard of Computer Information Systems before I graduated from high school. Fifty-nine percent of the students responded with somewhat agree, agree, or strongly agree, though only 16 percent strongly agreed with this statement.

2. Before I graduated from high school, I knew what Computer Information Systems was. Fifty percent of the students responded with somewhat agree, agree, or strongly agree, though only 10 percent strongly agreed with this statement.
3. Computer Information Systems is a fun career. Forty-one percent of the students responded with somewhat agree, agree, or strongly agree, though only two percent strongly agreed with this statement.

Furthermore, we asked non-CIS majors who have previously enrolled in a CIS class to answer the following two questions (n = 81):

1. I would take more Computer Information Systems courses, if available. Thirty-two percent of the students responded with somewhat agree, agree, or strongly agree, though only 2 percent strongly agreed with this statement.

2. Now that I understand more about Computer Information Systems, I am more likely to go into a Computer Information Systems career. Nineteen percent of the students responded with somewhat agree, agree, or strongly agree, though only 1 percent strongly agreed with this statement.

6. CIS RECRUITMENT STRATEGY

Given the results of this study, there are a number of possible recruitment strategies that CIS departments can undertake. While interest is not significantly different between the dependent variables in each of the MNL models, interest is highly influential in college major and career selection. A large percentage of non-CIS majors did not select CIS as their major because they are not interested in the CIS field. Interest can be sparked by exposing students to the field. One promising approach is to provide work experience for students. As Kim, Markham, and Cangelosi (2002) pointed out, business students tend to pursue a fit with perceived ability. Prior experience allows students to gauge their ability prior to selecting a major and can expose students to CIS careers. Other possible ways to expose students to the CIS field and for them to gain interest in the field through prior experience can come from internships, job shadowing, part-time employment, and allowing students to conduct special projects. Students suggested that information sessions could persuade them to select CIS as a major and a career. Considering that very few high school students know exactly what CIS is and that CIS has a less than exciting image, information sessions appear to be a good idea. However, exposure through experience in the CIS field is a more effective approach.

Since non-CIS majors are not likely to switch to CIS later, the timing of exposure and creating interest is important. Providing opportunities to expose students to CIS prior to students entering college is essential. CIS majors tended to know what major and career they wanted prior to entering college. In contrast, students in the other majors in this study tended to select their major after entering college. There is a significant advantage to introducing students to CIS in high school or earlier. This can be accomplished through extracurricular activities in high school or from influencers such as mothers, relatives, and advisors. Influencers from industry can be particularly effective. They can coordinate efforts with high school and middle school administrators and professional organizations. These efforts can lead to class presentations and summer programs as introductions to CIS subject matter. Industry people can also assist with CIS student clubs and mentorship programs.

The objective should be to give new learners opportunities to develop interest and then nourish that interest into the future. Knowing that behaviors change over time, continuing to reinforce interest and awareness with additional activities is important. With the assistance from higher education personnel, middle and high schools could create CIS learning paths so that students can continue to gain skills, confidence, and maintain continued interest so they are less likely to change their minds later. Furthermore, parents can get involved too. Since a parent's influence is significant, CIS professionals who are parents can assist in many of the school and professional work activities and provide support and encouragement for CIS careers. In summary, if CIS departments plan to recruit current college students for their major, it is likely that they will win over a small number of recruits. The larger impact and more effective approach however, is to focus recruitment efforts on the students who have not begun their college career.

7. CONCLUSION

One method to supply IT personnel for future job growth is to fill the pipeline of CIS majors. In order to attract students to CIS, effective recruitment strategies are essential. This research study is intended to improve the effectiveness of CIS recruitment initiatives by exploring the factors that influence a student's choice of major, when a student chooses a major, and when a career field is chosen.

The contributions that this paper delivers come from several directions. The research expanded the current CIS college major selection literature by consolidating in one study many of the variables dispersed throughout CIS college major choice studies and compared multiple business majors concurrently. However, there are three other primary contributions of this paper. First, it identified factors that influence when a major is chosen and when a career field is chosen, therefore a timely and targeted CIS recruitment strategy can be developed. Second, based on the findings of this study, suggestions for a recruitment strategy are proposed. Third, this study uses TPB as its theoretical foundation rather than TRA, thus including student performance (perceived behavioral control) as a construct, consequently expanding CIS college major selection research. The paper does this by extending TPB to the timing of when a college major is chosen and to when a career field is selected. The implications of this paper suggest that for CIS recruitment initiatives to be effective, the timing of the recruitment activities must be considered.

Limitations of this paper include the small sample size and that the sample was obtained from one university in the southeast United States. These limitations however, provide future research opportunities. Future research could replicate this study in other geographic regions, particularly focusing on securing a larger sample size and examining factors that influence when the CIS major is selected and when interest in the CIS career field begins. Further, the before college category could be expanded more to include middle school and each year in high school.

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Appendix

Table I Summary categorical variables, significance, theoretical construct

Categorical Variables	Fre-quency	Per-cent	Major Choice Model	When Major Chosen Model	When Field Chosen Model	TPB Frame-work
Major Choice [a]						B
Accounting, Finance & Banking, Risk & Insurance, Economics	19	14.5%				
Computer Information Systems [b]	40	30.5%				
Management, Int'l Business, Hospitality and Tourism	36	27.5%				
Marketing	20	15.3%				
Supply Chain Management	16	12.2%				
When Major Chosen [a]						B
Before College	34	26.0%				
Freshmen/Sophomore Year	73	55.7%				
Junior/Senior Year [b]	24	18.3%				
When Field Chosen [a]						B
Before College	46	36.2%				
Freshmen / Sophomore Year	41	32.3%				
Junior / Senior Year [b]	40	31.5%				
Gender			Y	N	N	ATB, SN
Female [b]	45	34.4%				
Male	86	65.6%				
Work Experience			N	N	N	ATB, SN
No	34	26.0%				
Yes	97	74.1%				
HS AP and IB Classes			N	N	N	PBC
AP	93	71.0%				
IB	4	3.1%				
HS Awards			N	Y	N	PBC
Academic Award	79	60.3%				
Special Recognition (Grades, Honor Roll)	100	76.3%				
Technical Skills Competition	21	16.3%				
HS GPA			N	N	N	PBC
Greater than 4.0	36	27.5%				
3.6 – 4.0	49	37.4%				
3.01 – 3.59	33	25.2%				
3.0 and less [b]	13	9.9%				
Extracurricular Activities	16	12.2%	N	Y	Y	ATB, SN, PBC
Student Government						
National Honor Society	53	40.5%				
Academic Club	38	29.0%				
Service Club	39	29.8%				
Vocational Club (DECA, VICA, FFA, FHA)	21	16.0%				
Who Influenced			Y	Y	Y	SN

Mother	42	32.1%				
Father	62	47.3%				
Relative	15	14.5%				
College Advisor	19	41.8%				
Personal Accomplishment	38	29.0%				
Mother's Education			N	N	N	SN
High School	15	11.5%				
Some College or Associates	42	32.1%				
Bachelors	53	40.5%				
Masters or Higher	21	16.0%				
Mother's Career Level			N	N	N	SN
No Work Experience	12	9.2%				
Hourly/Lower Level Salaried	55	42.0%				
Middle/Upper Level Salaried [b]	64	48.9%				
Father's Education			N	N	N	SN
High School	24	18.3%				
Some College or Associates	32	24.4%				
Bachelors	43	32.8%				
Masters or Higher	32	24.4%				
Father's Career Level			Y	N	N	SN
No Work Experience	4	3.1%				
Hourly/Lower Level Salaried	37	28.2%				
Middle/Upper Level Salaried [b]	90	68.7%				

Notes: [a] = Dependent Variables; [b] = Reference Category, Y = Significant, N = Insignificant; AP= Advanced Placement, IB = International Baccalaureate, HS = High School; Behavior = B, Attitude Toward Behavior = ATB, Subjective Norms = SN, Perceived Behavioral Control = PBC

Table II Summary metric variables, significance, theoretical construct

Metric Variable	Mean	Std Dev	Min	Max	Major Choice Model	When Major Chosen Model	When Field Chosen Model	TPB Framework
Influenced by High Starting Salary	5.702	1.201	1	7	Y	N	N	ATB
Influenced by Potential/Future Earning	6.046	1.007	1	7	N	N	N	ATB
Influenced by Prestige of the Field	5.336	1.206	1	7	Y	N	N	ATB
Influenced by Interest in the Field	6.084	0.953	1	7	N	N	N	ATB
Influenced by Positive Career Outlook	6.183	0.875	1	7	Y	N	N	ATB
Influenced by Prior Experience in Field	4.252	1.837	1	7	Y	N	Y	ATB, PBC
Influenced by Career Placement Test	3.809	1.701	1	7	N	N	N	PBC
Influenced by Books	3.382	1.561	1	7	N	N	N	ATB, SN
Influenced by Movies	3.458	1.693	1	7	N	N	N	ATB, SN
HS Math Proficient	5.400	1.722	1	7	Y	N	Y	PBC

Notes: N = 131; HS = High School; Y = Significant, N = Insignificant; Attitude Toward Behavior = ATB, Subjective Norms = SN, Perceived
Behavioral Control = PBC

Table III College major choice (Significant variables only)

Parameter	Sub Category	Major	Odds Ratio	Reciprocal of Odds Ratio	Standard Error	Wald Chi-Square	Significance
Gender	Male	Accounting / Finance	0.118	8.475	0.977	4.795	0.029
		Management	0.236	4.237	0.670	4.628	0.031
		Marketing	0.070	14.286	0.849	9.847	0.002
Who Influenced	Advisor	Accounting / Finance	0.024	41.667	1.216	9.341	0.002
	Advisor	Marketing	0.030	33.333	1.213	8.406	0.004
	Relative	Supply Chain	0.054	18.519	1.265	5.319	0.021
HS Math Proficient		Management	0.747	1.339	0.178	2.711	0.100
		Supply Chain	3.458		0.586	4.489	0.034
Influenced by High Starting Salary		Management	0.388	2.577	0.520	3.313	0.069
		Marketing	0.226	4.425	0.613	5.890	0.015
Influenced by Prestige in Field		Marketing	2.283		0.394	3.986	0.046
Influenced by Positive Career Outlook		Marketing	0.365	2.740	0.571	3.128	0.077
		Supply Chain	0.323	3.100	0.632	3.192	0.074
		Accounting / Finance	0.334	2.994	0.301	13.289	<0.001
Influenced by Prior Experience in Field		Management	0.714	1.401	0.197	2.926	0.087
		Marketing	0.651	1.536	0.260	2.744	0.098
		Supply Chain	0.634	1.577	0.269	2.858	0.091
Father's Career Level							
		Management	4.019		0.731	3.619	0.057

	Intercept Only	Intercept and Covariates	Chi-Square	Pr > ChiSq
-2 Log L	403.737	262.427		
Likelihood Ratio			141.310	<0.0001
Nagelkerke Psuedo R-square		0.692		

Notes: Reference Categories: Dependent Variable = CIS; Independent Variable, Gender = Female, HS GPA = 3.0 and less, Who Influenced = Yes; Father Career Level = Middle/Upper Management

Table IV When majors were chosen (in percent)

	Accounting/Finance	CIS	Management	Marketing	SCM
Before College	15.8	42.5	27.8	15.0	6.3
Freshmen/ Sophomore Year	63.1	45.0	55.5	65.0	62.5
Junior/Senior Year	21.1	12.5	16.7	20.0	31.2
n =	19	40	36	20	16

Table V When college major chosen (Significant variables only)

Parameter	Sub Category	When Major Chosen	Odds Ratio	Reciprocal of Odds Ratio	Standard Error	Wald Chi-Square	Significance
Who Influenced							
	Relative	Before College	8.728		1.370	3.109	0.064
	Mother	Freshman / Sophomore YR	0.083	12.048	0.795	9.850	0.002
	Advisor	Freshman / Sophomore YR	0.090	11.111	1.196	4.058	0.044
Extracurricular Activities							
	Student Gov't	Before College	22.055		1.347	5.278	0.022
	Student Gov't	Freshman / Sophomore YR	6.271		0.985	3.476	0.062
	Service Club	Freshman / Sophomore YR	0.142	7.042	0.856	5.207	0.022
	Academic Club	Freshman / Sophomore YR	0.209	4.784	0.812	3.720	0.054
HS Award Received							
	Grades / Honor Roll	Freshman / Sophomore YR	3.159		0.668	2.965	0.085

	Intercept Only	Intercept and Covariates	Chi-Square	Pr > ChiSq
-2 Log L	204.673	142.898		
Likelihood Ratio			61.776	<0.0001
Nagelkerke Psuedo R-square			0.437	

Notes: Reference Categories: Dependent Variable = Junior/Senior Year, Each Independent Variable = Yes.

Table VI When career field was chosen (in percent)

	Accounting Finance	CIS	Management	Marketing	SCM
Before College	35.3	42.1	43.3	26.3	18.8
Freshmen / Sophomore YR	23.5	26.3	33.3	52.6	43.7
Junior / Senior YR	41.2	31.6	23.3	21.1	37.5
n =	17	38	30	19	16

Table VII When career field is decided upon (Significant variables only)

Parameter	Sub Category	When Career Field Chosen	Odds Ratio	Reciprocal of Odds Ratio	Standard Error	Wald Chi-Square	Significance
Math Proficiency							
		Freshman / Sophomore YR	0.766	1.305	0.140	3.638	0.056
Who Influenced							
	Advisor	Before College	5.864		0.759	5.432	0.020
	Mother	Freshman / Sophomore YR	0.393	2.545	0.532	3.072	0.080
Extracurricular Activity							
	Technical Skills Competition	Before College	0.180	5.556	0.772	4.946	0.026
Influenced by Prior Experience							
		Before College	1.450		0.140	7.083	0.008

	Intercept Only	Intercept and Covariates	Chi-Square	Pr > ChiSq
-2 Log L	215.026	188.033		
Likelihood Ratio			26.993	.003
Nagelkerke Psuedo R-square		0.216		

Notes: Reference Categories: Dependent Variable = Junior/Senior Year, Independent Variables, Who Influenced and Extracurricular Activity = Yes.

Using Codecademy Interactive Lessons as an Instructional Supplement in a Python Programming Course

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Abstract

With the recent renewed interest in programming, online learning environments like Codecademy have become quite popular, boasting some 25 million members worldwide. The purpose of this paper is to describe the author's experience using Codecademy Interactive Lessons as an instructional supplement in an introductory Python programming course. The paper provides a brief background of the literature, a description of how the author implemented the interactive lessons, a discussion of the positives and negatives, the extent to which the interactive lessons met the course skill outcomes, and conclusions about the overall experience. In sum, the Codecademy Interactive Lessons fulfilled 3 of the 6 course skill outcomes and overall, the positives outweighed the negatives.

Keywords: Codecademy, Python programming, Interactive lessons, Online learning environments

1. INTRODUCTION

"Teaching the world how to code" ~ Codecademy

Codecademy provides free, online, interactive lessons for a variety of programming topics. Founded in 2011 by Zach Sims and Ryan Bubinski (Codecademy, n.d.), Codecademy purports to have 25 million learners around the world. According to their web site, Codecademy is "an education company" and the goal is to make Codecademy "the best place for our team to learn, teach, and create the online learning experience of the future" (About, n.d., para. 1). Because, "education is broken" (About, n.d., para. 4), Codecademy considers itself a disruptive force for "building the education the world needs – the first truly net native education" (About, n.d., para. 3). As the Codecademy web site asserts, "come help us build the education the world deserves" (About, n.d., para. 4).

The purpose of this paper is to describe the author's experience using Codecademy Interactive Lessons as an instructional supplement in an introductory Python programming course. The paper provides a brief background of the literature, a description of how the author implemented the interactive lessons, a discussion of the positives and negatives, an evaluation of the extent in which the interactive lessons meet the course skills outcomes, and conclusions about the overall experience. The focus of the paper centers on the implementation, evaluation, and fulfillment of course skill outcomes.

2. BACKGROUND

While there is a growing stream of research related to online learning environments in general (e.g., Herrington, Oliver & Reeves, 2003; Huang, 2002; Johnson & Aragon, 2002; Michinov, Brunot, Le Bohec, Juhel, & Delaval, 2011; Oncu & Cacir, 2011) and smart learning content (e.g. Brusilovsky et al., 2014), studies specifically focused on the use of Codeacademy as an instructional supplement are lacking. The

following are representative studies of the use of Codecademy for teaching and learning.

Kim and Ko (2017) included Codecademy in their study of online coding tutorials. They argue that the research investigating online learning environments for programming is both "sparse" and "narrow" resulting in "little holistic guidance about how to choose effective tutorials . . ." (p. 321). Based upon a set of curriculum design dimensions the authors identified four pedagogical principles to form the basis of the study including: (1) connecting to learners' prior knowledge, (2) organizing declarative knowledge, (3) practice and feedback, and (4) encouraging meta-cognitive learning. From these four guiding principles, the authors developed nine groupings by which to analyze the data collected. The nine groupings consisted of: (1) personalization, (2) utilization, (3) contents, (4) organization, (5) context, (6) actionability, (7) feedback, (8) transfer learning, and (9) support. Within these nine groupings, the authors derived 24 pedagogical principles specifically related to coding tutorials. In all but one of the principles, the authors marked them either yes or no. Across the 23 pedagogical principles Codecademy received 20 "yes" responses that it met the criteria. The authors concluded that "most online coding tutorials are still immature and do not yet achieve many key principles in learning sciences" (p. 325).

In a study exploring the design of online learning environment for programming education Olsson and Mozelius (2016) analyzed Codeacademy and MyProgrammingLab by asking the following question, "what are the most important factors in the design of virtual learning environments for self-learning of fundamental skills and knowledge"? (p. 534). They suggested that both "seem like promising additional tools for self-learning in programming courses at the university level" (p. 94). Using a case study research method they collected data via interviews, questionnaires, and group discussions. According to the authors the student's overall experience with Codecademy was positive. The immediate feedback, in particular, was cited by a students as a major benefit. Other features of Codecademy that students liked included the structure of the lessons and the forum. In sum, the authors identified the most important design factors as follows: (1) usability and user-friendliness, (2) clear and well-formulated feedback, (3) gamification, (4) unambiguous exercises, (5) GUI design and multi-modality, and (6) curriculum alignment.

In an attempt to increase student engagement and performance in a Fundamentals of Software Development course teaching Python programming, Fotaris, Mastoras, Leinfellner, and Rosunally (2016) gamified the course using the Kahoot! Classroom Response System, which is a game-based learning and trivia platform, the classroom version of the TV game show "Who Wants To Be A Millionaire?", and Codecademy's Python programming course. To implement the gamification strategy the authors replaced the traditional one-hour topical lectures with three 20-minute micro-lectures each followed by a Kahoot! session in which students responded to questions. The typical review session comprised of question and answer time was replaced with the "Who Wants To Be A Millionaire?" game consisting of Python-related questions. Finally, Codecademy's Python programming course was used for students to practice coding. For each of these components points were awarded and a leaderboard was provided in Blackboard. To gather data the authors observed student behavior, conducted an online survey, gathered self-reported data from students, and synthesized classroom administrative data such as attendance, tardiness, use of material, completion rates, and academic performance. Results of the study indicated an overall positive response from students to the gamified approach to the course, completion rates of assignments increased slightly, and overall student academic performance increased by about 8%.

Lee and Ko (2015) included the Codecademy Python course in a larger study designed to examine whether novice programmers "produced measurable learning outcomes" after using three different online learning tools. In addition to the Codecademy Python course, the tools included were Gidget and Gidget Puzzle Designer. Each of these tools represented a different form of online learning environment which Lee and Ko identified as tutorial, game, and canvas. Using a pretest-posttest research design the authors hypothesized that there would be "no difference in learner's post-test performance among the conditions after completing their assigned learning activity" (p. 238). Overall, the study indicated that none of the online learning environments resulted in statistically significant differences in student performance. However, there were statistically significant results in student performance between Codecademy and Gidget Puzzle Designer on the posttest, indicating that structured tutorials may improve student

knowledge over non-structured environments.

Figueroa and Amoloza (2015) incorporated three online interactive platforms into a multimedia course for non-computer science majors to study the impact of these platforms on programming anxiety and perceived learning. The platforms included Blockly, Code.org, and Codecademy. In this particular study, Codecademy's JavaScript programming course was used. Students were administered the Programming Anxiety Survey, consisting of six questions, before taking the course and after taking the course. The analysis of the survey data indicated a statistically significant difference between the average scores before and after taking the course. Furthermore, data collected also indicated a positive result among students in terms of perceived learning. The authors conclude that the combination of the three online interactive platforms resulted in "a significant decrease in learning anxiety and an increase in perceived learning among students who took the course" (p. 65).

3. IMPLEMENTATION

Codecademy Teaching Resources

As a part of its educational strategy Codecademy provides several teaching resources including teacher training, class resources, and classroom tracking. Teacher training allows instructors to go through the same interactive lessons as the students free of charge. Class Resources include free lesson plans and quizzes. Classroom Tracking allows the instructor to create student accounts and to track individual performance by overview and by unit. The tracking allows for the instructor to see the percentage of each individual course completed.

Course Requirements and Outcomes

While planning to teach Python programming for the first time, the author decided to implement the interactive Python lessons provided by Codecademy. The idea of these free, online, interactive lessons was appealing to the author as an additional means to potentially engage students beyond the traditional textbook materials. He was curious to see how the student's would respond to the interactive nature of the lessons and see if the students thought they were a worthwhile activity in addition to the customary quizzes, exams, and assignments.

The course itself was offered online in an 8-week summer session via Blackboard Learn 9. A total of thirty students were enrolled in the course. The majority of students were either Computer Information Systems or Information Technology majors (25 out of 30). The course consisted of 26 men and 4 females.

Rather than offer the interactive lessons as an optional supplement for which the students could complete or not complete, the author decided to require the interactive lessons as a part of the course requirements constituting 10% of the overall course grade. This decision was made to motivate the students to complete the interactive lessons. A breakdown of the course requirements and percent of course grade is provided in Table 1. A list of the knowledge and skill outcomes is provided in Appendix A.

Course Requirements	**%**
Lab Assignments	35%
Codecademy Interactive Lessons	10%
Quizzes	10%
Exams (2)	30%
Final Exam	15%

Table 1. Breakdown of Course Requirements

Topics Covered

The textbook for the course was "Starting Out with Python Programming" (Gaddis, 2018). Because the course was taught in an 8-week summer session the author covered the first six chapters: (1) Introduction to Computers and Programming, (2) Input, Processing, and Output, (3) Decision Structures and Boolean Logic, (4) Repetition Structures, (5) Functions, and (6) Files and Exceptions. While the Codecademy Python course consists of 21 individual courses covered in 36 lessons the author selected those courses which matched the content of the textbook chapters: (1) Python Syntax, (2) Tip Calculator, (3) Strings & Console Output, (5) Conditionals & Control Flow, (7) Functions, and (14) Loops (See Appendix B). Additional courses were available to provide students an opportunity to apply the concepts from the main courses. For each textbook chapter the associated interactive lessons were provided on the course schedule (See Appendix C).

4. POSITIVES AND NEGATIVES

Positives

The author identified several positive aspects of implementing the Python interactive lessons as an instructional supplement. First, and perhaps most obvious, the interactive lessons are free. With the rising cost of traditional textbooks and the additional expense of adding publisher's interactive content (e.g., MyProgrammingLab) they provide an easily accessible, no-cost

alternative which is quite attractive to both instructors and students.

Second, the interactive lessons are self-paced and students can repeat the individual courses as many times as they wish. If the student is having difficulty with a particular topic they can spend as much time with it as needed. Additionally, students can access the content at their convenience and do not need to install special software or have lab access. With Internet access and a browser the student is good to go.

Third, because of the interactive nature of the lessons student receive immediate feedback on the code that they are writing. It is no surprise to instructors that today's students prefer hands-on activity over reading a textbook or passively listening to a lecture. The author found that the feedback provided by the interactive lessons was user-friendly and provided enough guidance to scaffold the learning experience and help to solve logical or syntactical errors.

Finally, from the author's perspective, setting up and managing a Codecademy course via the Classroom Tracking interface was quite simple and intuitive. Basically, the instructor chooses the course they want to use and then can customize its name and description to match the course syllabus. The instructor then adds the students to the course and a username and password is automatically created for each student. Students can be added, edited, and deleted at any time. An easy-to-follow "Pupil Tracker Guide" is provided by Codeacademy. The students can then login and change these items if they choose. As students complete individual courses the tracking interface displays an overview of each student's progress as well as individual performance by lesson. The author then entered the completion percentage into the gradebook in Blackboard. The performance matrix can also be downloaded as a comma-separate values (.csv) file and opened and edited in Excel.

Negatives

The implementation of the Python interactive lessons was not without its negatives. As with any interactive coding environment there is limited opportunity for creativity by the students since the "solutions" are predefined. The downside of this approach is that students only see potentially one way of solving a problem – they are not allowed to think "outside of the box". Another possible downside is that they simply employ a trial-and-error approach to problem solving until they receive the correct answer rather than enlisting critical thinking skills. As with any instructional strategy students may simply rush through the interactive lessons to get them completed rather than taking their time to learn, understand, and apply the content.

From the author's perspective, there were actually very few negatives from the standpoint of creating and managing the Python course in Codecademy. It would have been nice if the students were automatically notified that their accounts were created and what their username and password was rather than the author having to send an individual message to each student in Blackboard. The fact that the author had to manually enter the percent completed values from the tracking system to the Blackboard gradebook was also a bit time-consuming.

5. EVALUATION OF SKILL OUTCOMES

In addition to identifying the positives and negatives, the author evaluated the use of Codecademy as an instructional supplement in terms of meeting the course skill outcomes (see Appendix A).

SO1: Students will create Python programs using the Python interpreter and the IDLE IDE

Because the Python lessons are embedded within the Codecademy online, interactive environment a specific interpreter and/or IDE is not used. This skill outcome was met outside of Codecademy using the Python interpreter and IDLE IDE provided on the Python website.

SO2: Students will apply the steps in the program development process

The program development process followed was that provided by Gaddis (2017): (1) Design the program, (2) Write the code, (3) Correct syntax errors, (4) Test the program, and (5) Correct logic errors. This skill outcome is partially met using the interactive lessons. The structure of the majority of the interactive lessons is to provide students with a prompt to write a single line of code and provide immediate feedback or to provide students with partial code for which they complete. Students are not required to design and write a program from start to finish. Some may find this as a shortcoming of the interactive lessons as they provide only partial snippets of code to be completed, rather than working through the full program development process.

SO3: Students will implement variables, literals, and constants

The interactive lessons provide students the opportunity to implement variables, literals, and

constants. Students are required to declare variables, literals, and constants and assign appropriate values to them. These exercises are provided in Lesson 2 - Python Syntax, Exercises 10-13; Lesson 3 - Tip Calculator, Exercises 1-5; and Lesson 4-5 - Strings & Console Output, Exercises 1-13.

SO4: Students will select appropriate arithmetic, logical, and relational operators
The interactive lessons provide students the opportunity to select appropriate arithmetic, logical, and relational operators. These exercises are provide in Lesson 2 - Python Syntax, Exercises 10-13; Lesson 3 - Tip Calculator, Exercises 1-5; Lesson 7 - Conditionals & Control Flow, Exercises 1-10.

SO5: Students will implement sequence, selection, and repetition control structures
The interactive lessons provide students the opportunity to implement sequence, selection, and repetition structures. These exercises are provided in Lesson 2 - Python Syntax, Exercises 10-13; and Lesson 9 – Conditionals & Control Flow, Exercises 11-15; Lesson 24-25 – Loops, Exercises 1-19.

SO6: Students will analyze, design, implement, test, and debug domain-specific applications which demonstrate basic computation, input/output, control structures, operators, exception handling, and functions
The interactive lessons partially provide students the opportunity to analyze, design, implement, test, and debug domain-specific applications demonstrating basic computation, input/output, control structures, operators, and functions. Coverage of functions is provided in Lesson 11-12 – Functions, Exercises 1-19. As noted in SO2, the design of the interactive lessons lack the ability for the students to create full programs from scratch, instead providing partial code snippets for completion.

In sum, the Codecademy interactive lessons met three skill outcomes (SO3, SO4, and SO5), partially met two skill outcomes (S02, S06) and did not meet one skill outcome (S01). See Table 2 for a summary of the evaluation of the skill outcomes as either met, partially met, or not met.

Outcome	Met	Partially Met	Not Met
SO1			X
SO2		X	
SO3	X		
SO4	X		
SO5	X		
SO6		X	

Table 2. Evaluation of Skill Outcomes

6. CONCLUSION

Overall, the author's experience with the Codecademy interactive lessons for Python was positive in terms of an instructional supplement to the textbook materials. The interactive lessons provided adequate depth and breadth of the Python syntax and allowed students additional coding practice with immediate feedback in an environment conducive to their own schedule and learning speed. Additionally, the interactive lessons met or partially met five of the six course skill outcomes. Another upside being that the students were afforded this opportunity with no additional cost to the course. For those perhaps interested in implementing one of the interactive lessons the management is simple and intuitive and is not a significant addition of time commitment to the instructor. While anecdotal comments might be made from the student's perspective at this point, a potential opportunity for future research is to survey students on their attitudes toward the benefits and challenges of the interactive lessons and to correlate completion percentages with overall course grade.

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Appendix A - Knowledge and Skill Outcomes

Knowledge Outcomes:

- Students will become familiar with the Python interpreter and the IDLE Integrated Development Environment (IDE)
- Students will describe the steps in the program development process
- Students will explain the characteristics of variables, literals, and constants and their appropriate usage
- Students will distinguish between arithmetic, logical, and relational operators and their appropriate usage
- Students will identify and describe sequence, selection, and repetition control structures
- Students will describe exception handling
- Students will understand the benefits of modularization and the use of functions

Skill Outcomes:

- Students will create Python programs using the Python interpreter and the IDLE IDE
- Students will apply the steps in the program development process
- Students will implement variables, literals, and constants
- Students will select appropriate arithmetic, logical, and relational operators
- Students will implement sequence, selection, and repetition control structures
- Students will analyze, design, implement, test, and debug domain-specific applications which demonstrate basic computation, input/output, control structures, operators, exception handling, and functions

Appendix B - Overview of Codecademy Python Lessons Used*

Lesson	Course	Exercises	Objectives
1	1. Python Syntax	1-9	• Become familiar with Codecademy platform • Understand why Python is used and recognize basic terminology including 'variables' and 'Boolean' • Understand and create whitespace and multi-line comments
2	1. Python Syntax	10-13	• Perform mathematical operations using python syntax • Create numbers using 'modulo' • Practice creating comments, variable and arithmetic operations
3	2. Tip Calculator	1-5	• Plenary activity synthesizing lessons 1&2: Python syntax • Create a 'tip calculator' using python syntax, variables and arithmetic operations
4	3. Strings & Console Output	1-9	• Explain what a string is and how to create one • Create variables using indexing • Implement lower(), upper() and str() string methods • Compare when dot notation should be used
5	3. Strings & Console Output	10-13	• Demonstrate how to print strings and variables including how to concatenate • Explain how to convert a non-string into a string and why you would need to • Demonstrate how to use the % operator
7	5. Conditionals & Control Flow	1-4	• Understand what control flow is • Recognize and practice using 6 comparators (==, !=, <=, >=, <, >) • Explain what a comparator is
8	5. Conditionals & Control Flow	5-10	• Recognize 3 types of Boolean operations (AND, OR, NOT) • Demonstrate how to use Boolean operations to return 'True' or 'False' values
9	5. Conditionals & Control Flow	11-15	• Recognize IF, ELSE and ELIF statements • Create simple controlled flows using IF, ELIF and ELSE statements • Practice creating control flow with conditionals and Boolean operations
11	7. Functions	1-11	• Demonstrate and understand how to define a function with and without parameters • Demonstrate and understand how to call functions • Demonstrate importing functions both specific and universal • Practice creating functions
12	7. Functions	12-19	• Demonstrate and understand what the max, min, abs and type functions do • Practice making functions
24	14. Loops	1-8	• Understand how a While/ Else loop functions • Understand how to prevent an infinite loop • Create while loops integrated with lists, inputs and mathematical operators
25	14. Loops	9-19	• Plenary: Practice making loops using the correct syntax • Understand how a For/ Else loop works • Create a For/ Else loop

*Adapted from Codecademy Python Unit Overview

Appendix C – Course Schedule

Date	Tentative Schedule	Assignment Due*	Quizzes**	Codecademy Lessons***
Week 1 June 12-18	Course Introduction Chapter 1 - Introduction to Computers and Programming			
Week 2 June 19-25	Chapter 2 - Input, Processing, and Output	Lab 01*	Ch 00**	
Week 3 June 26-July 2	Chapter 3 - Decision Structures and Boolean Logic	Lab 02*	Ch 02**	Python Syntax & Tip Calculator Strings & Console Output
Week 4 July 3-9	**Exam 1 (Chapter 1-3)**	Lab 03*	Ch 03**	Conditionals & Control Flow
Week 5 July 10-16	Chapter 4 - Repetition Structures	**Exam 1****		
Week 6 July 17-23	Chapter 5 - Functions	Lab 04*	Ch 04**	Loops
Week 7 July 24-30	**Exam 2 (Chapter 4-5)**	Lab 05*	Ch 05**	Functions
Week 8 July 31-Aug 6	Chapter 6 - Files and Exceptions	**Exam 2****		
Week 9 Aug 7-13	**Final Exam**	Lab 06* **Final Exam****	Ch 06**	

A Preliminary Study: The Use of VoiceThread in Online Business Courses

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Abstract

This study explored the use of a web-based tool, VoiceThread, as it relates to enhancing active learning and learner engagement in two online business courses. VoiceThread was integrated into various learner-centered activities supporting learner-learner, learner-content and learner-instructor interactions as part of an online course improvement process. As a result, using VoiceThread in two asynchronous courses created an online learning community, and promoted active learning and learner engagement in both courses.

Keywords: active learning, asynchronous teaching, Information and Communication Technology (ICT), learner engagement, VoiceThread.

1. INTRODUCTION

Rapidly changing technological advancements necessitate continuous adjustments of higher education online course development, design and delivery for quality learning to be achieved. Overlooking technological disruptions can easily cripple the development and delivery of quality online learning. To replicate face to face learning, particularly, promoting active learning and

learner engagement, online educators need to adapt compatible Information and Communication Technologies (ICTs) when designing asynchronous pedagogies.

The researchers of this study conducted a preliminary analysis to gain an insight into how a web-based tool could support active learning and learner engagement in two asynchronous online courses at a state university located in the Midwest. The study included learners made up of two small groups.

The learning outcomes of the two courses were based on "internally stored states of the human learner, called capabilities" (Gagné, Briggs, & Wager, 1992, p. 43), and included "intellectual skill, cognitive strategy, verbal information, motor skill, and attitude" (Gagné, Briggs, & Wager, 1992, p. 44). By supporting these capabilities, and other criteria, VoiceThread (VoiceThread LLC, 2016) was identified as a compatible option which would enable a similar face to face learning context.

The features of VoiceThread were described in three dominant words: "Communicate, collaborate, connect" (VoiceThread Features, 2017, para 1.). These features also supported active and collaborative learning, one of National Survey of Student Engagement Indicators & High-Impact Practices benchmarks (National Survey of Student Engagement [NSSE], 2016) defined as "some of the more powerful contributors to learning and student behavior" (Kuh, 2009, p. 16).

As a cloud-based application, VoiceThread (VoiceThread Features, 2017) became a powerful choice as it could be accessed from any computer and web browser, and would keep learner data secure. Furthermore, the tool was diverse in that it allowed learners to create, comment and share, offering different methods of communication with "over 50 different types of media… five powerful commenting options" (VoiceThread Features, 2017, para 1).

In addition to identifying and implementing a compatible technology, adapting a standardized quality assurance model for an online course design, delivery, and improvement was as critical. In this study, the two online courses were designed and delivered based on a benchmark model, Quality Matters Higher Education Rubric General Standards and Specific Review Standards (Quality Matters [QM], 2014). Since the quality assurance model was based on promoting three types of interactions, learner-learner, learner-content, and learner-instructor, it provided a suitable framework for active learning and learner engagement to be clearly observed (Moore, 1989; QM, 2014, 2017).

2. REVIEW OF LITERATURE

Literature on digital learning is growing rapidly as more institutions adapt technologies to deliver online courses. Quality online teaching and learning is made possible by means of staying atop of disruptive technologies. As many universities adopt online programs, virtual faculty discover that using and sharing multiple approaches in teaching and learning have become the norm as noted by Pacansky-Brock (2012): "As an educator utilizing emerging technologies for teaching and learning, understanding the value that sharing brings to our culture is critical" (p. 38). Faculty also discover these technologies by trial and error as the focus of developing online courses is to "explore and trial new technology-enabled pedagogical approaches" (Futhey, 2015, p. 123).

With opportunities there exists a myriad of challenges related to learner engagement. Limiting courses to discussion boards is no longer an option (Negash & Powell, 2015). The first and foremost aim of an online quality learning would be to identify compatible technologies which support program and course learning outcomes, and mirror active learning practices of face-to-face classes since "all too frequently the lack of the human element in online classes is cited as an inherent weakness of online classes" (Pacansky-Brock, 2013, p. 5).

In addition, "online classes are most potent when they use multiple methods and processes in order to convey the information and the experience of applying the information" (O'Fallan, 2010, p. 199). As new ICTs enter the scene, more and more opportunities exist to increase learner interactions transforming the asynchronous teaching environment with "a strong sense of community" (Rovai & Jordan, 2004, p. 3). These online communities are designed to encourage "the feelings of friendship, cohesion, and bonding that develop among learners as they enjoy one another and look forward to time spent together" (Rovai, 2002, p. 42) followed by "trust" which is comprised of "credibility and benevolence" (Rovai, 2002, p. 42).

One such technology, VoiceThread, serves as a virtual community enabling learners to easily communicate, get involved and engage in a variety of activities, encouraging more

collaborative interactions which is an integral part of online learning (Thurmond & Wambach, 2004). Furthermore, the tool promotes the "multi-sensory interaction on learning in general" (VoiceThread Research, 2016, para.1) as well as supports the definition of learning as a human adaptation process (Kolb, 1984).

When VoiceThread was introduced to online learners, the bulk of research in the use of VoiceThread was found in K-12 literature (Negash & Powell, 2015; Hew & Cheung, 2013). Since then, research on VoiceThread in higher education has been noteworthy (VoiceThread Research, 2016). One such study revealed that university undergraduates in an *Introduction to Technology* course used an array of digital tools, including VoiceThread: "The findings show that the undergraduates were generally able to use unfamiliar technologies easily in their learning to create useful artifacts" (Ng, 2012, p. 1065). Another study by Ching and Hsu (2013) found that "about half of the participants indicated that they preferred VoiceThread to text-based discussion forums for collaborative learning activity" (p. 298).

When adapting such technologies, online educators also need to offer learners a context for reflective thinking (Siemens & Tittenberger, 2009) which entails "a mental process with purpose and/or outcome in which manipulation of meaning is applied to relatively complicated or unstructured ideas in learning or to problems for which there is no obvious solution" (Moon, 1999, p. 161). A reflection activity is an essential part of learning as it is "characterized by engagement, pondering alternatives, drawing inferences, and taking diverse perspectives, especially in situations which are complex and novel, calling for situational awareness and understanding" (Higgins, 2013, p. 1). In this study, engagement was "a term used to represent constructs such as quality of efforts and involvement in productive learning activities" (Kuh, 2009, p. 6).

As noted by Garrison (2003) "the collaborative and reflective properties of asynchronous online learning offer the potential to create an environment with both social and cognitive presence" (p. 48). Creating such contexts needs to be designed with one focus in mind "the cognitive aspects of the educational process if quality learning outcomes are to be the result" (Garrison, 2003, p. 48).

When VoiceThread was integrated into the course to enhance quality learning, a leading quality assurance model, the Quality Matters (QM) Higher Education Rubric General Standards and Specific Review Standards (QM, 2014) provided the much-needed evaluation with a standardized checklist to ensure that quality online learning was delivered.

Quality benchmarking for course development, evaluation, and improvement of online and blended courses serves as a focal point for streamlining quality online delivery systems (QM, 2017). A leading quality assurance model, QM, utilizes design standards which focus on learning from the learner point of view with eight rubric areas: 1) course overview and introductions, 2) learning objectives or competencies, 3) assessment and measurement, 4) instructional materials, 5) course activities and learner interaction, 6) courses technology, 7) learner support, and 8) accessibility and usability (QM, 2014).

At the university where the research was conducted, QM Higher Education Rubric General Standards and Specific Review Standards (QM, 2014) had already been in use, and faculty members including the researchers had been trained in QM. As a result, the researchers were able to adapt the QM rubrics with ease and be able to identify and implement a compatible technology, in this case, Voice Thread (VoiceThread LLC, 2016).

Figure 1. How Creation Works in VoiceThread

VoiceThread supported "the objectives and competencies to enhance learning" (QM, 2014, p. 25) for online learners located away from each other, replicating similar face-to-face settings. As a result, at first glance, the researchers observed that the creation of a context in an online community which focused on quality learning and

encouraged collaboration and active learning provided a rich and powerful experience for the learners since "collaborative learning promotes social interactions and the development of learning communities for knowledge sharing" (Ching & Hsu, 2013, p. 299). Figure 1 illustrates the collaborative nature of the tool regarding how learners are encouraged to engage one another, building on the comments of others.

3. METHODOLOGY

Purpose of the Study

As part of the course improvement and delivery plan, the researchers sought to identify and adopt a collaborative tool with the intent of creating an online community to support active learning and learner engagement.

VoiceThread (VoiceThread LLC, 2016) was used for two online business courses, *Professional Development,* and *Methods of Individual Training and Job Analysis* at a business college of a state university in the fall semester of the 2016 academic year. These two courses were categorized as graduate level courses, but both courses enrolled undergraduates as well.

During the time of the study, the university had both on campus and virtual students. The online program had over 10,000 enrolled students, and the overwhelming majority of the online students were working adults with families.

The two asynchronous courses used in this study had been improved with the introduction of new technologies over the years. The goal of the technologies was to promote active learning and learner interactions by means of text-based blogs, wikis, discussions, and stand-alone reflections.

The following central question was posed to guide this preliminary study: Does VoiceThread promote active learning and learner engagement in an asynchronous setting to replicate face-to-face learning context?

VoiceThread

To be able to fully integrate a compatible web-based tool into asynchronous courses, the researchers started out with three questions: 1) What are examples of engaging and collaborative tools? 2) How can instructors utilize these tools to maximize learner opportunities to further develop learner beliefs and mental models? 3) What are some approaches that maximize collaboration and feedback opportunities, both between the instructor and learners and between the learners themselves?

The second step was to employ criteria to confirm the compatibility of VoiceThread (iTunes, 2016; VoiceThread LLC, 2016) for these two online business courses. The following five criteria supported this decision.

First, VoiceThread had been integrated into the university's official learning management system (LMS), Blackboard (Blackboard, 2017). This meant that the much-needed technology support for the researchers was present. In addition, training related to new technologies was frequently made available by the administration as part of faculty professional development.

Second, VoiceThread also supported the quality assurance model used by the researchers, and was compatible with the "course objectives and competencies to enhance learning" (QM, 2014, p. 25).

Third, with VoiceThread course learning outcomes were addressed covering all five capabilities: "intellectual skills, cognitive strategy, verbal information, motor skill, and attitude" (Gagné, Briggs, & Wager, 1992, p. 44).

Fourth, the platform offered a virtual community in which learners would easily communicate, get involved and engage in a variety of activities resulting in collaborative interactions which was an integral part of online learning (Kuh, 2009; Thurmond & Wambach, 2004).

Fifth, the platform also served as a context for reflection (Siemens & Tittenberger, 2009) which also supported learner engagement.

Once the decision to integrate VoiceThread into the course was made, the course was designed to offer learners, prior to the VoiceThread activities, and earlier in the course to complete an orientation session, make their introductions, and become acquainted with each other. These initial phases were particularly fundamental as "emphasis on online interactions can help generate a group identity, particularly if the interaction is a component of collaborative work" (Rovai, 2002, p. 53). In addition, the learners were also made aware of issues ranging from course design to understanding the rubrics which set the parameters for effective communication.

The course also provided the learners with a set of instructions as indicated in Appendices section (Figure 2, Figure 3, Figure 4, and Figure 5) to be able to understand the mechanics of the platform

to make meaningful contributions. This would enable learners to develop a "strong sense of classroom community which [sic] could have a positive influence on student academic performance" (Rovai, 2002, p. 43).

Case 1: VoiceThread and Course 1

For fall 2016, the course entitled *Professional Development* was made up of a total of 17 students, including 12 undergraduate and five graduate students.

The course learning objectives were defined as follows: 1) Comprehend the causes, issues, and approaches to career change. 2) Discuss the value of networking and how you might apply networking to your career or job. 3) Discuss the value of professional learning communities. 4) Develop and establish a Personal Learning Network (PLN). 5) Discuss the impact of the following on your career path: organizational culture, diversity, and coaching and mentoring. 6) Propose a written a personal six-part Personal Marketing Plan (PMP). 7) Describe your assessment of your own Emotional Intelligence (EI). 8) Determine the work force of your chosen career path in the year 2030.

The two textbooks required for the course were: *Emotional Intelligence 2.0* (Bradberry & Greaves, 2009), and *What Motivates Me: Put Your Passion First* (Gostick & Elton, 2014). The course as it appeared in the syllabus was defined as the study of various aspects of professional development and their importance to success in the business environment. The emphasis of the course was on developing an understanding of the role of motivation and emotional intelligence. Learners were required to mold their career, interviewing techniques and resume development, and to build their reputation with LinkedIn (2017), and manage their organizational and personal change. In addition, learners took two self-assessments including one on motivation and another on emotional intelligence (EI) answering two questions: 1) What motivates and inspires you; and 2) can you read your own emotions as well as the emotions of others?

The course included a total of six VoiceThread activities for the learners. The instructor used the following detailed instructions for each activity as described below.

Instructions for Activity 1. Select one of the topics listed below and place in VoiceThread. Relate one of these items to your work experience. Respond to one other classmate. I have posted my video to begin the use of this communication tool. Be sure you meet the Voice Thread rubric requirements. The rubrics are all found under "Start from Here" on the left-hand menu. The topic choices are as follows: 1) Define "job sculpting." Have you sculpted or been sculpted? Tell us about your experience. 2) Does Jimmy Casas' story have any meaning to you? 3) Does Steven Reiss' story carry any meaning to you? 4) React: The motivations that drive us are the hinges upon which our lives swing, and it is only when we understand what makes each of us passionate about our work that we can begin to bring about a personal boom in our activity.

Instructions for Activity 2. Select one of the following and provide citations from your textbook, *What Motivates Me: Put Your Passion First* (Gostick & Elton, 2014) in your analysis: 1) What helps people feel engaged, enabled, and energized in their daily work? 2) What factors increase of decrease levels of job satisfaction? 3) What is it that makes people want to quit a job? 4) Respond to the following comment: What motivates a labor-and-delivery nurse is vastly different from what motivates an emergency room nurse or an oncology nurse: "But we have been treating them all the same—they have all been 'nurses' to us" (Gostick & Elton, 2014, p. 27).

Instructions for Activity 3. Read chapters 1-2 of *Emotional Intelligence 2.0* (Bradberry & Greaves, 2009), and take the Emotional Intelligence Appraisal. Select one of the items below and respond in VoiceThread. Respond to one other classmate. 1) Can you relate to Butch Connor's story? Explain. 2) "It's so easy to forget that we have emotional reactions to almost everything that happens in our lives whether we notice them or not" (Bradberry & Greaves, 2009, p.14). Comment. 3) React to the image on page 19 of your book. 4) React to the image on page 20 in your book.

Instructions for Activity 4. After you review the documents below, share your recent or past job search experience. What did you do well? What would you change? If this does not really apply to you, how do you intend to conduct your job search? Place your thoughts in VoiceThread and respond to one other classmate.

Instructions for Activity 5. Select one of the relationship management strategies. Where have you seen it applied? Comment on the event and reply to one other classmate.

Instructions for Activity 6. Tell us five ideas, concepts you feel you now have a greater

understanding of. Or another way of putting it, what do you know now that you did not know before this course? Respond to one other classmate.

Case 2: VoiceThread and Course 2

The course entitled *Methods of Individual Training and Job Analysis* enrollment for fall 2016 consisted of a total of eight students including five undergraduate and three graduate students. The textbook used for the course was: *Planning Programs for Adult Learners: A Practical Guide* (Caferella & Daffron, 2013).

The course description as appeared in the course syllabus was to examine and identify planning procedures, and strategies that would lead to effective talent development programs for adults who would learn in a wide variety of settings. Learners would gain skills in course planning models, needs assessment, marketing, evaluation, and program management.

The course objectives were as follows: 1) Explain how you can add value by help building a learning organization. 2) Discuss the challenges of training a multi-generational workforce. 3) Analyze "current trends in training and development and awareness of the current state of the profession." 4) Examine the incorporation of social media tools into learning events. 5) Discuss the role of feedback and how feedback is effectively utilized to enhance learning. 6) Discuss how the positive role storytelling can play in learning by telling an effective story. 7) Build the components of effective new hire training/on-boarding programs.

The course included a total of six VoiceThread activities with explicit instructions from the instructor as described below.

Instructions for Activity 1. Reflect on each of the nine assumptions in the textbook. Select two assumptions. How have you seen these assumptions at work in your company or in past training assignments? Where have they not been taken into consideration in your experience? What were the results? Place in VoiceThread. I have started the conversation. Here is the process, acknowledge what you have heard from someone who posted before you by name. Then, add your comments to the chain. As your instructor, I will also enter my comments into VoiceThread more than once. Be sure you review the rubrics for VoiceThread in the "Start from Here" tab on the left hand menu of Blackboard.

Instructions for Activity 2. Chapter 3, pages 75-77 lists 14 chapter highlights. Select any two chapter highlights and comment related to where you have seen them in practice. Place in VoiceThread. Be sure you review the rubrics for VoiceThread in the "Start from Here" tab on the left hand menu of Blackboard.

Instructions for Activity 3. Look over Exercise 4.3 on page 105 of your textbook "Negotiating in situations that are grounded in deeply held values that differ among stakeholders." Select one of the three questions and reply in VoiceThread.

Instructions for Activity 4. On page 127 of your textbook, you will find six chapter highlights. Select one chapter highlight and comment on where you have seen it in practice and post in VoiceThread. Respond to one other classmate.

Instructions for Activity 5. Select a chapter of your choice. Place your reactions in VoiceThread by responding to the following questions: Where have you have not seen it in practice and what were the results? To help you prepare for the mid-term on chapters 1-7, answer the following questions: What is the most imparting new concept you have become aware of? Why is it an important concept? Place your comment in VoiceThread and reply to one other classmate.

Instructions for Activity 6. Tell us five ideas, concepts you feel you now have a greater understanding of. Or another way of putting it, what do you know now that you did not know before this course? Respond to one other classmate.

Discussion

In all activities, based on choice theory (Beresford & Sloper, 2008), learners were given a choice and asked to select the topic from a list of alternative issues related to the course objectives tied to the reading. In addition, while initially encouraging the use of video, learners had a choice in response medium- video, audio or written text.

Moreover, learners were asked to reflect and relate the materials to their real-life experiences. The method for learner response was to respond to a classmate of their choice and then add their unique comments.

In both courses, the last activity was to reflect on the entire course by means of using the following instructions: Tell us five ideas, concepts you feel you now have a greater understanding of. Or another way of putting it, what do you know now that you did not know before this course?

Respond to one other classmate. This reflection was adapted from an After Action Review (After Action Review [AAR]. 2017) which served as tool used at the end of the course to improve their learnings. The AAR (2017) is a powerful tool which can be used during or after a completion of a project and "can help future teams learn your successful strategies and avoid pitfalls you have worked to overcome" (para. 1).

Learners responded to a classmate of their choice, and the instructor also responded, individually and collectively. In all cases, by responding to one other classmate, learners were encouraged to engage and reflect.

Similar to online discussion forums, the learners expected instructor feedback related to the activities. The instructor provided individual as well as collective feedback using different technologies and tools. This allowed the VoiceThread community conversations to remain as a standalone community in which conversations flowed without interruptions.

Once the learners started to build conversations, the instructor used various other tools for feedback One feedback tool was audio podcasts, via Soundcloud (Soundcloud Tumblr, 2017) which is described as "an audio platform that lets you listen to what you love and share the sounds you create" (Soundcloud Tumblr, 2017, para. 1). In this case, at times the link was stand alone and, at other times, feedback was provided on a set of notes taken as the instructor listened to the VoiceThread comments of each learner.

Other times video feedback was provided with a link to a specific YouTube (2017), or a link to a video created using Swivl (2017), a tool that allows split screen, presenter on the left and slides on the right. Finally, occasional feedback was presented to learners in the form of a pdf file related to the overall topic.

4. FINDINGS AND CONCLUSIONS

Throughout the course, the instructor, who was one of the researchers, was able to observe all learner activities as the numbers of learners in each course did not make up a large group. The instructor took daily notes regarding their collaboration and their comments and shared it with other researchers. Other researchers also had access to the course.

The last reflection activity in both courses offered a platform so that the learners could provide and share their feedback (AAR, 2017; Moore, 1989; Quality Matters, 2014, 2017). These reflections provided the researchers with textually rich data (Creswell, 2015).
These data included positive adjectives, nouns, noun phrases, and verbs describing learner feelings, thoughts, and perspectives on active learning and learner engagement. One of the researchers had a linguistics background and acted as an expert in deciphering the lexicon used by the learners. These texts did not have any negative words or phrases. Findings included positive phrases which indicated that VoiceThread was a useful tool which promoted active learning and learner engagement. Since this was an initial analysis with two small groups, further research is recommended regarding ICTs and learner engagement and active learning with larger groups.

This preliminary inquiry demonstrated the ways in which VoiceThread (VoiceThread LLC, 2016) could promote a dialog, and engagement between learner and instructor, learner and content, and learner and learner by encouraging a collaborative learning environment. In addition, by offering a supportive environment, VoiceThread was able to encourage active learning and learner engagement. The tool also proved to be an effective learning tool which also met QM Higher Education Rubric General Standards and Specific Review Standards (QM, 2014), creating a supportive environment and encouraging more active learning.

Anecdotal data and qualitative analysis of learner feedback, learner-learner interactions, instructor observation and verbal communication throughout the course indicated that VoiceThread (VoiceThread LLC, 2016) was instrumental in encouraging more interactions and support, resulting in creating a much-needed virtual community. Learners in both courses indicated that they "belonged" to a community, they could "trust" their classmates related to their "experiences" and "rely on them" when needed. These findings supported the concepts of classroom community articulated by Rovai (2002). Similar findings were noted by Fallon (2011): "…majority of students, using the classroom helped build trust and rapport and went some way toward developing a sense of identification with others in the group—three important components in relationship formation."

The words and phrases used in describing learner feelings and thoughts throughout the two courses were positive. All learners used similar phrases to describe their feelings: "felt challenged," "felt supportive," "felt successful," "felt organized,"

"being helped," "being encouraged," and "felt needed." Majority of the learners indicated that the interactions with their classmates "helped" them "improve" their skills and used descriptions like "better team members," "was able to help solve problems," "able to listen to others." In addition, reflections by means of video, text "encouraged" learners to "share their experiences and learn from the experiences of each other." Learning from each other was fundamental as the two courses taught professional training and prepared them for the workforce.

Furthermore, all learners revealed that being part of a "learning community" encouraged them to be "open" with other learners and their instructors. Many learners revealed feelings related to a "supportive and friendly community" by noting that they were "not intimidated," they did not feel "peer-pressure," they felt that they "belonged" to a community and "enjoyed studying with others."

This rich feedback from the learners supported the capabilities and effect of VoiceThread as a powerful tool since learners were able to use their method of choice to communicate and engage with others as the tool offered "over 50 different types of media… five commenting options" (VoiceThread, 2017).

During the learning process, the instructor also observed how learners communicated with their classmates as if they were in a face to face learning setting. When verbally asked by the instructor what learners felt using VoiceThread as a course tool, all learners in both courses responded positively with phrases similar to felt part of the group including "felt belonged," "felt included," felt welcomed by my friends." Having experience in face to face courses, all learners were able to make comparisons as well. When asked verbally by the instructor how learners viewed this virtual community setting when compared to a face to face learning setting, almost all learners with experience in both types of learning contexts indicated that they found support in their virtual groups just like they did in their face to face classes. In fact, 70% of the learners went further and indicated that they found more support in a virtual setting.

Related to active learning, all learners felt they were "proactive in their learning" and "felt engaged" in active learning. Having a sense of "belonging" in a supportive online community supported more "interactions" with other learners, and thus encouraged learning.

Regarding implications, although this is a preliminary analysis, online learning, when compared to face to face learning, should not be considered a system that lacks quality. The general concept of online courses not offering the same quality as a face to face setting can be misleading. Online courses can provide learners with similar face to face contexts, and possibly much more, provided that these courses integrate compatible and innovative technologies in their courses to promote learner interactions.

In addition, using a quality benchmarking model is another fundamental step when it comes to delivering quality online programs.

5. FURTHER RESEARCH

This paper was limited in that it presented the use of VoiceThread (VoiceThread LLC, 2016) in two online courses as part of business education curriculum. In addition, the two groups in the study were relatively small. The researchers recommend that future studies of ICTs in higher education online courses be conducted, particularly with larger groups. While it is easier to manage smaller groups and have more interactions, the researchers recommend exploring learner engagement using larger groups.

The researchers suggest the following research topics to determine the efficacy of ICTs regarding active learning and virtual learning communities: 1) a longitudinal study with larger groups to determine the efficacy of ICTs in supporting active learning and learner engagement; 2) a study on the effects of learner-learner interactions on active learning in larger asynchronous classes; 3) a correlational study to determine the relationship between ICTs and retention in learning communities; and 4) an explanatory study on ICTs as it relates to learner engagement using National Survey of Student Engagement Indicators & High-Impact Practices (NSSE, 2016).

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Appendices

Figure 2. Instruction for VoiceThread Self-Introduction. Learners were given the following instructions to get started: 1) Hover your mouse over the VoiceThread you want to share. The overview will pop up. 2) Click on the "Share" button. As directed by VoiceThread (VoiceThread LLC, 2016).

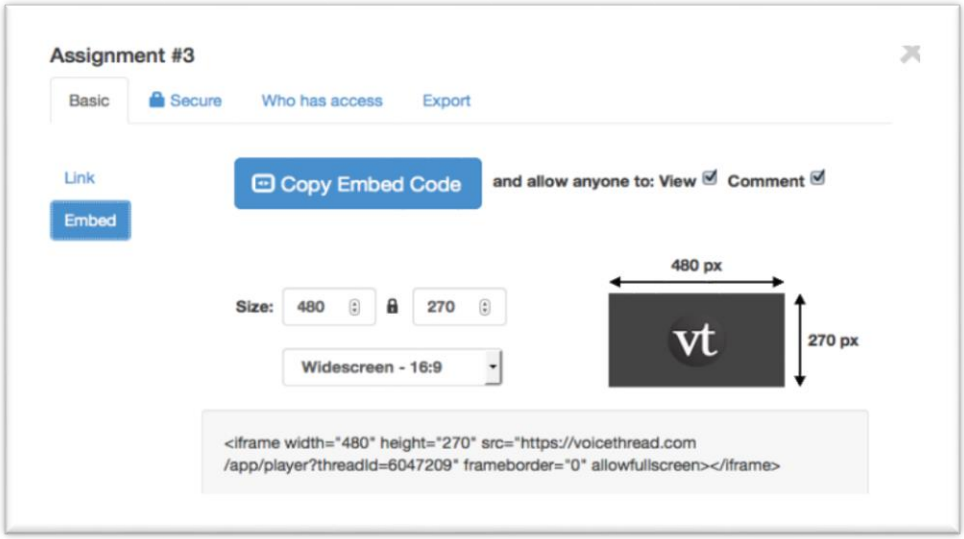

Figure 3. Instruction for VoiceThread. Learners were given further instructions: 3) On the basic tab, click on the "Embed" button on the left. 4) Un-check the boxes for allowing anyone to comment if you want only users to view your VT. 5) Use the controls to decide what size and shape your embedded VoiceThread will be. The code below will update automatically. 6) Click the button to "copy Embed code". This copies that code to your computer's clipboard so that you can paste it on the desired location. As directed by VoiceThread (VoiceThread LLC, 2016).

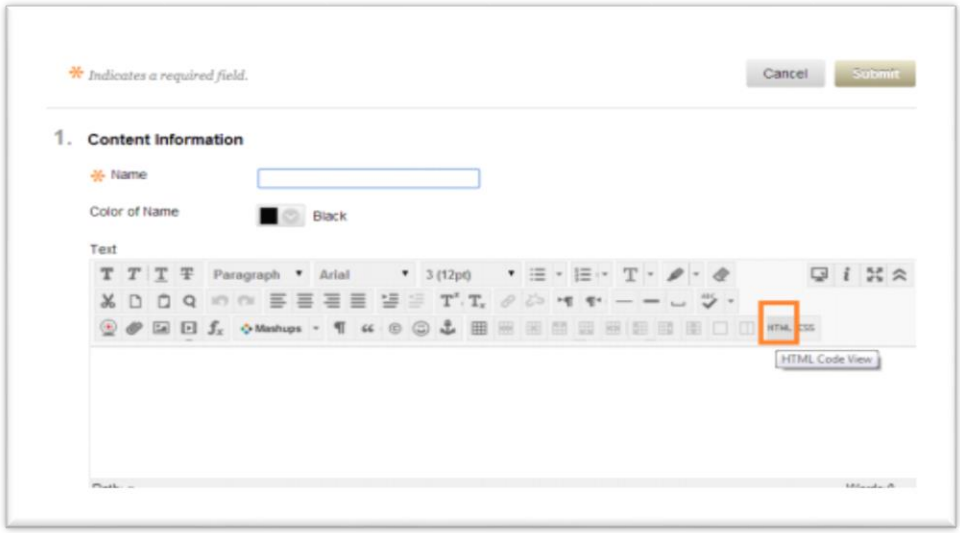

Figure 4. Instruction for VoiceThread continued. 7) Go to your Blackboard course where you would like to share the VoiceThread presentation. Build content and create an Item, then paste your embed code in HTML box. As directed by VoiceThread
(VoiceThread LLC, 2016).

Figure 5. Instruction for VoiceThread continued. 8) After you click submit, the VoiceThread will show up to students in your course like the following image. Students can directly view/comment your video inside of your course without going to VoiceThread website. As directed by VoiceThread (VoiceThread LLC, 2016).

Applying an Agile Approach in an Information Systems Capstone Course

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Abstract

This paper outlines the content of a Master of Science in Information System degree and the development and deployment of the first two iterations of the capstone course. Research shows that a capstone course can be valuable for both students and future employers. The steps taken to prepare for the course and set up the capstone course are included. Students utilized an agile methodology, Scrum, with regular meetings and five sprints. Students answered questions about their experience with the capstone course and the findings from two cohorts of students are shared. The paper concludes with considerations for future follow up and iterations.

Keywords: capstone, agile, Project-based Learning, Scrum, real world client, system analysis and design

1. INTRODUCTION

University graduates seeking career opportunities want to prove to employers that they are ready to contribute to companies or organizations. Employers want people who can work well on teams as well as be lifelong learners. Capstone courses are used in academic degree programs in different kinds of schools such as business, engineering, information technology, health care and education (Schwering, 2015). When students enroll in a capstone course, they often gain skills and insight that will help in their career. The central challenge for information systems graduates is to productively design, implement, and manage information systems, and to do so in a timely fashion (Carlsson, Hedman, & Steen, 2010). A graduate capstone course can provide proof of educational effectiveness of a program.

A regional public state university in the Midwest created a Master of Science degree in Information Systems (M.S. in I.S.) and included a one-semester capstone project course. Students in the program take courses in technical areas including object-oriented programming, networking, business intelligence, cybersecurity, and databases. They learn business and management knowledge through project management, information systems, and financial modeling. They acquire and practice UX design, requirements gathering, and systems diagrams with student projects. Students learn how to analyze and think through ethical and professional dilemmas they may face in a computing career. These courses all help students develop the knowledge and skills to complete the capstone project. They use the technical skills for the technology component, the management skills to manage the project, and professional skills to interact appropriately with the client.

The capstone course uses the principles of Project-Based Learning (PBL) as an instructional

strategy. Student teams using PBL research and devise solutions to projects while increasing communication and problem solving skills (Bell, 2010). Several studies have found PBL to add authentic learning experiences for students (Bell, 2010; Danford, 2006; Genc, 2015; Ozdamli & Turan, 2017).

Many instructors have incorporated agile methodologies into their class projects (Magana, Seah, & Thomas, 2018; Mahnic, 2012; Taipalus, Seppänen, & Pirhonen, 2018) with overall positive results. Our students learn about agile methodologies including Scrum in their coursework including a project management course with concepts, cases, and a project using Scrum. The project in the capstone course allows students to practice implementing a larger project using agile methodologies.

The rest of the paper is organized as follows. In the next section, a literature review covers the basics of capstone courses, PBL, and agile methodologies. Then the design of M.S. in I.S. capstone course is summarized and the implementation of this project-based course is explained. Results of the survey including significant findings are shared. The conclusion includes plans for future course iterations as well as lessons learned.

2. LITERATURE REVIEW

A capstone course is placed at the end of the curriculum and allows students to assess and share their achievement of the program's outcomes (Hobson, Johnston, & Spinelli, 2015; Schwering, 2015). Capstone courses review program goals, lead students through a structured reflection to become self-directed learners, and communicate students' academic accomplishment to professional peers (Cuseo, 1998). A study showed that employers preferentially valued a student's capabilities of using knowledge to solve real world problems (Schwering, 2015). Capstone courses also compel students to be self-directed learners (Wallace, 2015). The advancing and changing technical environment in today's companies require information systems graduates to be able to learn new technologies on their own.

Project-Based Learning (PBL) is one strategy that can be used to help students develop into independent thinkers and learners (Bell, 2010). Students engaged in PBL have more control over their learning and the tasks they complete; the projects have less structure and are more complex than typical assignments (Taipalus et al., 2018). These projects generally do not have one right answer (Martí, Gil, & Julià, 2006) which can be frustrating to students while providing a more authentic learning experience. Students can develop creative and research skills while also being more active in the project solution (Genc, 2015).

Students engaging in PBL are focused on an end project and it is often expected to be an excellent product (Danford, 2006). Genc (2015) used PBL in an environmental education class where students created projects on environmental problems. Students working on projects had a more positive attitude regarding the subject (Genc, 2015). Danford (2006) had corporate clients work with student teams to develop market research for corporations. Other classrooms have tried using PBL including a mobile application development course (Ozdamli & Turan, 2017) and a computer graphics course (Martí et al., 2006).

While studies generally report positive findings, some challenges are regularly noted when using PBL. Unhealthy group dynamics, poor time management, stress of big projects, and communication problems are often noted (Danford, 2006; Ozdamli & Turan, 2017). Another challenge for any instructor seeking to use real world clients is convincing the corporate world of the value of becoming involved in the experience (Danford, 2006).

Increasingly companies are using agile methodologies in their development and planning activities. Most systems analysis and design and software engineering courses introduce both traditional and agile software development methodologies. The four core values of the Manifesto for Agile Software Development is "individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, and responding to change over following a plan" (Agile Alliance, 2018, p. 1). Given the prevalence of agile, practicing these concepts in student projects is important.

Over half of today's companies use Scrum (Magana et al., 2018) with the overall success rate of projects using Scrum at 62 percent (Denning, 2015). Scrum is an agile software development process for small teams (Rising & Janoff, 2000). Scrum is made up of sprints, which are short durations of time, usually about 2 to 4 weeks. Teams must complete a set of product functions during every sprint (Baird & Riggins, 2012).

Generally, there are three roles in a project using Scrum. In a class project, the students are part of the project team. The instructor becomes the Scrum Master, and the client is the product owner (May, Yoir, & Lending, 2016). When the teacher is in the role of Scrum Master, he or she is serving as a facilitator; the teacher as a facilitator is also a key idea in PBL (Danford, 2006; Guthrie, 2010). In some class projects, the instructor may also be the product owner or may do some of the tasks a product owner typically completes.

Faculty are increasingly using the Scrum framework in student projects (May et al., 2016). The integration of an agile methodology in a capstone project is a natural fit (Sharp & Lang, 2018). Practitioners say "in many ways Scrum is a study in the learning process itself" so exposure while in college seems appropriate (Echols, 2016, p. 10).

3. COURSE DEVELOPMENT & DELIVERY

The purpose of this course is to help students integrate the knowledge gained during the M.S. program in IS by facilitating a student-executed Information Systems project, including requirements, design, documentation, and a fully functional prototype. This course is designed as a team project where teams work for a real industry client to address a real business problem. The project typically covers the conceptualization, analysis, design, and production of a working, functional prototype of the system that serves as a proof of concept on which a final system may be built. It may also involve a pilot and/or implementation. Students are expected to bring knowledge from the rest of the program as well as their own unique experience. Students in this course will apply this knowledge to information systems practice using different tools and techniques while respecting others' views, in an effort to learn how to be effective IS professionals.

The topics that are addressed in the capstone course include: information systems development methods and techniques, agile methods and techniques, prototyping, participative design, project management methods and techniques, database design and management, information systems (IS) security, systems architecture, usability theory and methods for presentation, and reporting. Thus, the course covers the full spectrum of information systems development from conceptualization and analysis to design, prototyping, and development, depending on the project assigned to the student groups. The student groups need to synthesize knowledge on complex topics to complete the capstone projects.

Since the course focuses on a real-world information technology problem that the students have to solve as a team, this is not a lecture course but rather a series of project meetings. The project is managed through on-going consultation with the professor, teaching assistant and other advisors invited by the professor. In addition, advisory and Socratic educational practices are incorporated as a key pedagogical component in the course. The project problem is typically offered and owned by an organizational representative. The organization can be a local business or organization or a campus office or organization. The client is involved in the entire project life cycle.

There are two student group meetings every week. Each group must develop a meeting agenda. The professor plays primarily a mentoring and facilitating role in this course. In consultation with the professor, the students define the scope of their work and define the structure of the project meetings. Each meeting agenda and process is student-prepared and has to be approved by the professor. During the rest of the week, student groups work on specific assignments that are defined during the project meeting. Groups present their results during each weekly meeting. A summary of each weekly meeting is sent to the problem owner (the client) at the end of the meeting. To successfully complete this capstone course, students need to submit the following assignment and deliverables associated with planning and completing their team projects.

Project prototype: The expectation is that the project team will deliver a working (functional) prototype that meets the client's requirements.

Interim Deliverable Documents: The team will submit interim deliverable documentation that includes both system analysis and design specifications and project management documents. Documents may include, but are not limited to, requirements and design documentation, test plans, test reports, burndown charts, Gantt charts, and other documented artifacts. Students could choose the technologies; most groups used Moqups, Justinmind, and Wix.

Final report: Each team will submit a final report that includes the documents prepared during the development process. This report will include the memorandum of understanding, the statement of

work, the technology plan, the feasibility study, use diagrams and use cases, the test plan and results of the testing, and the agendas and minutes from each meeting.

Final presentation: Each project team will make a formal presentation that showcases the prototype to the client, members of the University faculty, and other interested individuals. The presentation should include a demonstration of the prototype as well as a presentation of the project process, including a post-mortem.

This capstone course is a 3-credit graduate course offered in the fourth semester of the M.S. in I.S. program. It has been taught for two semesters now. Students are assigned to project teams according to their varied knowledge levels, learning abilities, and work experience. The professor used specific criteria to balance the teams to avoid one team having an advantage over another team and to ensure that all teams could be effective. Each team consists of five or six members. Each team should finish one independent project within 15 weeks to meet the course requirements and objectives.

As suggested by literature, IS practitioners should regularly work cross-functionally with business users when implementing systems (Maloni, Dembla, & Swaim, 2012). In our previous IS courses, students typically relied on professors, other faculty members or even themselves to collect user requirements. This is not truly cross-functional in nature. To address this gap, we sought outside clients for these projects. The city manager and the new conference center manager from the local community agreed to serve as clients for the first semester. A new conference center was set to open at a local lake, and four information systems projects were needed. The four systems were: employee management system, beverage management system, room management system, and supply management system. The students were able to tour the new conference center to understand the facility better, and then the client came to campus for the remainder of the project meetings and presentations.

The professors were not able to secure an outside client for the second semester so two on-campus clients served as clients for the projects. The projects were a professional inventory system for the Learning and Teaching Center and a student success center reporting system for the campus Student Success Center.

After the professor introduced the syllabus and course structure, the client representative came to class for a kick-off meeting to provide basic information about their organization and their need for an information system. The clients remained involved throughout the project, providing requirement details, responding to information requests, and offering feedbacks to each team's interim prototypes. The client representatives periodically attended project teams' review meetings, and frequently communicated with project teams via email. An active, involved client is essential for success in these projects.

Students applied Scrum methodology to manage their projects. The system prototype development was divided into five sprints with different sprint backlogs, which were the prioritized lists of tasks to be completed. Besides daily Scrum meetings, students attended two 75-minute classes per week for team meetings and consultation with the professor. At the end of each sprint, the potentially deployable prototypes were demonstrated to the client. The clients were able to see and understand what the system looked like and were able to give direct feedback. This was effective and allowed students to practice using an agile methodology.

Students completed peer/self-evaluations after every sprint. They provided quantitative and qualitative feedback to every team member, grading each team member's effort and quality of work during the sprint. The peer review results were reviewed by the professor and summarized for students. After giving feedback to students, the professor met with individual team members regarding the existing issues and discussed how to improve their performance. Peer review provides an opportunity for "correction" of performance and quality issues with individual team members.

The projects in both semesters were deemed successful by the course professor and the clients. All capstone projects were completed by the end of the semester. The teams presented their system prototypes to the client in final presentation session. Final reports for each system were submitted to the client together with the prototypes.

4. DATA ANALYSIS

The students completed a survey to gain insight on their experience in the program and the capstone course. The survey is included in Appendix A.

Students answered 18 questions about their capstone experience including questions about the client, team, communication, project management principles, and Scrum. Thirty-four students participated in the study as the first cohort had 22 students while the second cohort had 12 students. The questions used a 5-point scale with 5 being strongly agree and 1 being strongly disagree.

Table 1 shows the mean scores for each question. Overall, the mean scores were high, indicating a positive learning experience for the student.

Question	Mean 1-5 scale N = 32
Team worked well with client	4.12
Open dialogue with client	4.50
Client effectively involved	4.21
Easy to communicate w/ team	3.82
Use of correct communication media	4.15
Team communication timely	3.91
Use of formal project mgt processes	4.06
Team followed project plan	4.21
Tasks clearly assigned	4.00
Had knowledge/skills to be successful	4.06
Could get help with technical	4.24
Prototype is successful	4.32
I will get a good grade	4.29
I learned a lot	4.29
Project expanded thinking & skills	4.21
Project was realistic	3.74
Scrum was appropriate	4.26

Table 1: Mean scores from survey

Since each capstone course is different due to the projects and clients, further analysis was done on the two groups to see if there were any differences in their answers. An independent-samples t-test was conducted to compare ratings between Cohort 1 and Cohort 2. The results are shown in Table 2.

There was a significant difference in the scores for Cohort 1 (M=4.32, SD=.72) and Cohort 2 (M=4.83, SD=0.39) on the question about open dialogue with clients; t(32)=-2.72, p=0.011.

	Cohort 1 (n = 22)		Cohort 2 (n = 12)		df = 32	
	M	*SD*	*M*	*SD*	*t*	*p*
Work with client	4.14	.71	4.08	.79	.20	.849
Open dial. w/ client*	4.32	.72	4.83	.39	-2.7	.011
Client involve	4.18	.73	4.25	1.1	-.22	.826
Team comm.	3.68	.95	4.08	.90	-1.2	.238
Team media	3.95	.95	4.5	.52	-1.8	.078
Team timely comm.	3.91	.92	3.92	1.0	-.02	.982
Formal PM	4.05	.58	4.08	.90	-.15	.882
Team project plan*	3.95	.79	4.67	.49	-2.8	.008
Task assign.	3.86	1.1	4.25	.86	-1.0	.310
Know/ Skills*	3.77	1.0	4.58	.67	-2.4	.019
Tech. help	4.09	.68	4.50	.52	-1.8	.081
Proto. succ.	4.32	.65	4.33	.78	-.06	.952
Good grade	4.18	.80	4.50	.67	-1.2	.249
Learn a lot	4.27	.70	4.33	.99	-.21	.836
Expand skills	4.14	.71	4.33	.89	-.71	.484
Project real.	3.77	.92	3.67	.89	.33	.748
Scrum appro*	4.05	.72	4.67	.49	-2.7	.012

*Significant

Table 2: Results of t-test

These results show Cohort 2 who worked with on-campus clients reported significantly higher ratings on having an open dialogue with the client. The second cohort had higher scores for each of the other questions where significant differences were found. There was a significant difference in the scores for Cohort 1 (M=3.95, SD=1.02) and Cohort 2 (M=4.58, SD=.67) on the question about the team following a documented project plan; t(32)=-2.84, p=0.008. A significant difference was found in the scores for Cohort 1 (M=3.77, SD=.79) and Cohort 2 (M=4.67, SD=0.49) on the question regarding if the team had the knowledge and skills necessary to

successfully complete the project; t(32)=-2.47, p=0.019. Also a significant difference in the scores for Cohort 1 (M=4.05, SD=.72) and Cohort 2 (M=4.67, SD=0.49) regarding whether Scrum was an appropriate project management method for the capstone project was discovered; t(32)=-2.65, p=0.012.

Qualitative comments from the cohorts were also analyzed. Positive comments from cohort 1 centered around the value of working with a real world client while several students in cohort 2 mentioned the lack of an external client as a weakness of their experience. Some students in both cohorts mentioned that they wanted to do more than just create a prototype in the capstone project. Positive remarks from cohort 2 included an overall good experience with professor support, Scrum, and the project management processes.

5. DISCUSSION OF FINDINGS

Students participating in the capstone course experience several advantages. First, the capstone projects provided students with systems analysis experience in the professional world. Students learned effective team collaboration skills necessary for their future careers. Second, students needed to integrate the knowledge gained from a variety of discipline-based courses they have studied in the curriculum. They had to draw together learning from all graduate courses and apply these concepts to a real-world business problem setting. This capstone course could deepen students' appreciation of the discipline as an approach to specific problems (Carlson & Peterson, 1993). Third, the project may have increased student engagement. Another study of students who worked on industry projects found that students were more committed to spending time on the projects and executed greater effort as they were more motivated to deliver quality results (Marcketti & Karpova, 2014).

Other studies have surveyed students to get their perspective on capstone projects using Scrum. Baird and Riggins (2012) and Mahnic (2012) found the students were satisfied with the hybrid project management methodologies that included Scrum principles. While both cohorts reported positive ratings, some differences in scores and comments require further review.

One common theme was the role of the client. Clearly both cohorts prefer to work with an outside client, likely due to the idea that the experience is more beneficial when interacting with an industry client (Marcketti & Karpova, 2014). The fact that the first group had a very public outside client with news coverage on their project may have made Cohort 2 doubt the value of their projects with on-campus clients. However, the on-campus clients were more available to the student groups, leading to the statistically significant higher rating on open dialogue with client from Cohort 2. Given that the scores on several questions were lower for the first group, the degree of client involvement appears to be vital. Other studies have also found that lower client involvement can lead to overall lower satisfaction (Baird & Riggins, 2012). We thought there was value to an outside client, and this finding validates it and leads the professors to identify more outside clients and make sure they can be available for students to ask questions.

We try to identify clients by reaching out to members of our professional advisory team and community organizations. The advisory team members may have a project at their company or be involved with a group that has an information systems need. Often our clients are non-profit or small companies who lack the resources to pay for similar services. Our graduate applied computer science program has worked with outside clients for several years. We are attempting to develop a system where the prototype the IS students develop is handed off to the computer science students for development.

A second finding centers on the other three areas where Cohort 1 ratings were statistically significantly lower than Cohort 2. These items were documented project plan, knowledge and skills, and whether Scrum was an appropriate project management method. There could be various explanations for this including higher expectations of Cohort 1 since this group also gain lower course evaluations or perhaps a learning curve and processes were refined in the second iteration of the course.

Over thirty percent of the students indicated that they did not think developing a proof-of-concept prototype was enough for the capstone project. Professors realize the challenge of creating working applications in a short time period and want to keep client expectations reasonable (Schwering, 2015). Baird and Riggins (2012) also believed that a proof-of-concept project was most appropriate but allowed students to try new packages and cloud-based solutions. In future iterations, we plan to allow students to experiment with this. We are planning to use Mendix, a platform that would allow development

without too much time coding. We still want the emphasis to be on systems analysis, design, and project management.

As with all student projects, there were some issues with groups. Schwering (2015, p. 100) used "a diagnostic survey that evaluates 30 attributes of team and leadership performance." He found that having students complete the survey twice during the project allowed them to enhance their strengths and address weaknesses. Students reported the survey required them to think about their leadership skills in ways they had not before (Schwering, 2015). We could use this survey or an instrument like it to help students develop their skills and work better in teams.

6. CONCLUSION

There are some limitations in the results from our study. The small sample size of 32 is enough to do some analysis but more data from more cohorts would make the findings more relevant. It is difficult to find appropriate real-world projects and clients for a short-term development. Our university is in a small town, which limits the potential clients. Clients for these projects need to be committed to communicating with the students in a timely manner while also realizing there are no guarantees of the project outcome. We have found this to be the most challenging part of organizing and delivering the class.

The project-based course generated heavy workload on professors, and student work and stress levels were high which is typical in a project-based course (Marcketti & Karpova, 2014). Since teaching Scrum in the classroom and using it in industry appears to be standard, not a fad (May et al., 2016), the effort to create the capstone experience with a good client and using Scrum principles is worthwhile.

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Appendix A: Capstone Course Experience Survey

Directions: Indicate the choice that best fits your response using the following scale:

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

1. Our team worked well together with our client.
2. We had an open dialogue with our client during the project.
3. The client was effectively involved in our project.
4. It was easy to communicate within the entire project team.
5. Team members used the right communication media (e.g., discussion boards, e-mail, face-to-face meetings, etc.).
6. Our team communicated in a timely manner.
7. Our team used formal project management processes.
8. Our team followed a documented project plan to guide our work.
9. Specific project tasks were clearly assigned to team members.
10. We had knowledge and skills necessary to successfully complete this project.
11. We could always successfully obtain answers to technical questions from available resources (e.g., class, Internet, etc.).
12. Our final project submission and prototype is successful.
13. We will receive a good grade on this project.
14. I learned a lot from this Capstone project.
15. This Capstone project expanded my thinking and skills.
16. This Capstone project was realistic.
17. Scrum is appropriate project management method for this Capstone project.

Please share any comments you have regarding the Capstone course and project.

The Contribution of the CISSP (Certified Information Systems Security Professional) to Higher Education Research

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Abstract

Information Security has been a challenge since humans began keeping information. With the advent of computerized data and computer networks, that challenge has increased dramatically. Not only are more breaches occurring, but public knowledge about those breaches is now commonplace adding to virtual hysteria concerning data and information security. To combat the challenge, many organizations are turning to trained and experienced security specialists. Educational institutions are adding curriculum to support the training and education of security professionals. To ensure quality education, many institutions are relying on security certified instructors. One certification highly sought after is the Certified Information Systems Security Professional (CISSP). The educational benefits of CISSP led courses is quite obvious. What is not as obvious is the contribution of the CISSPs to the academic body of knowledge. This paper is an attempt to summarize the current contribution of the CISSP to the academic body of knowledge and open a dialog about the expectations of CISSP to higher educational research.

Keywords: CISSP, Information Security, Security Education, Security Research

1. INTRODUCTION

A Brief Overview of Information Security

There are many parts to Information Security. Cryptography, perhaps the oldest form of Information Security, has been around for a very long time. As early as the 1900s B.C. (and perhaps even earlier), the ancient Egyptians developed hieroglyphics and the ancient Sumerians developed cuneiform. From substitution and transposition ciphers, to modern digital encryption, there have been numerous iterations of cryptography and cryptanalysis. Some of the most notable have occurred in recent history and utilize machinery to improve the capabilities, such as Enigma in World War II (Kahn, 1996).

The modern age of computers and networks further impacted cryptography with digital encryption techniques, ranging from the Data Encryption Standard (DES) in the 1970s to the Advanced Encryption Standard AES in 2001, the Triple DES, and various wireless standards (Stewart, Chapple, & Gibson, 2015). After cryptography, perhaps the oldest issues surrounding Information Security are Physical Security and Social Engineering.

Physical Security deals with preventing others from being able to physically get to the data. We've all heard of buried treasure with secret maps showing "X" marks the spot! That's really not too far off the mark. Physical security includes locked doors (of varying sophistication), fences, guards and guard dogs, cameras, lighting, etc. As technologies advance, so do the capabilities of physical security (Stewart et al., 2015).

Social Engineering is the art of getting someone to divulge information they shouldn't. Some of the best known social engineers are probably Susan Headley and Kevin Mitnick. Susan was active in the 1970s and 80s and is known for hacking into military computers. She would often obtain the information by having sex with military officers, then go through their belongings to find usernames, passwords, etc. while they slept. She was involved in phreaking with Kevin Mitnick, but framed him after they had a falling out, leading to his capture and conviction in 1995. Kevin was a gifted social engineer and hacker in the 1990s, but after his arrest, conviction, and five-year jail term, he is now a widely sought-after security consultant. He is heavily into testing computer security strengths, weaknesses, and loopholes. He also involved in security awareness training and mobile intrusion detection systems (Johnson, 2010).

The Internet has been the greatest facilitator to information security attacks. It enables anyone with a computer to have access to virtually anyone else with a computer, as long as they are connected to the Internet. Even computers that aren't connected to the Internet risk intrusion through dial-up connections or lax physical security. There are loopholes and backdoors into many different computing and networking operating systems, computer applications, smart phone apps, etc (Stewart et al., 2015). While these problems have been around for many years, recent events are really bringing the issues into focus. In the past few months alone, there have been notable security breaches utilizing the Internet. Equifax was breached putting the data of over 145 million people at risk. Yahoo revealed that over 3 billion accounts were hacked. Russia's alleged influence on the last presidential election. Uber had the data of 57 million customers stolen. Ransomware, where hackers lock systems and require payment for unlocking, is on the rise with payments exceeding $2 billion in 2017 (Larson, 2017). There seems to be no end in sight.

The Information Security Professional

To combat the increasing Information Security needs, organizations are turning to Information Security Professionals. Those trained and/or experienced specifically in Information Security. Certifications can help identify experts in various areas of Information Security. Certifications range from entry-level or area specific, such as GIAC Security Essentials and Secure+, to others require more experience or cover wider ranges of topic areas, such as Certified Ethical Hacker (CEH) and Certified Information Security Manager (CISM) (Anderson & Schwager, 2002; Cooper, 2016). One of the most widely recognized and accepted certifications is the overarching Certified Information Systems Security Professional (CISSP) offered by the International Information Systems Security Certification Consortium (ISC)2. The CISSP covers a wide range of security areas or Domains (there are eight), and requires candidates to have five years' experience in at least two of them (Stewart et al., 2015).

Many educational institutions are offering certificates, degrees, concentrations, etc. in Information Security. To make these programs more attractive to students, many institutions are looking for instructors who are certified in at least some area of Information Security (Andersson & Reimers, 2009; Frank & Werner, 2011). As it has the widest coverage of security domains, the CISSP is one of the most sought-after certifications for educators. However, teaching is not the only focus of higher education – increasing the research and body of knowledge is also very important. In addition, "Advance and protect the profession" is one of the prime canons of the CISSP code of ethics (Stewart et al., 2015). So, the focus of this paper is on the contribution of the CISSP to the academic body of knowledge.

There are two parts to this study. The first part is to discover what is being written about CISSPs and the second is to determine what is being written by CISSPs. This two-pronged approach gives a wholistic perspective on how CISSPs are influencing academia and adding (or not) to the body of knowledge. While there is no requirement for non-CISSP authors to write about CISSP topics, the research may still provide insights into the importance of CISSPs to higher education. CISSPs themselves, on the other hand, are expected to contribute to the profession, so how academic CISSPs are adding to the educational body of knowledge may be useful.

2. LITERATURE ANALYSIS

The first step in analyzing the contribution of the CISSP was to find all the academic articles written by or about them. An extensive search of article databases was conducted, searching for the term "CISSP". The included computer-related databases were: ACM Digital Library, IEEE Xplore, Applied Science and Technology Source, ScienceDirect, and ProQuest Central. Disciplines other than computers might also utilize CISSP as authors or topics, so the search also included Academic Search Complete and Business Source Complete. The search yielded 207 articles spanning 1995 to the early 2017, when the

search was conducted. Table 1, below, shows the yearly distribution with one article in 1995 to a high of 26 in 2013. Interestingly, the number of articles each year increased from the one in 1995 until 2007 when the distribution leveled off at about 17 articles per year, with the notable exception of the 26 articles in 2013. The appearance of the conference proceedings and the ISEDJ journal are greatly enhanced by standardized formatting.

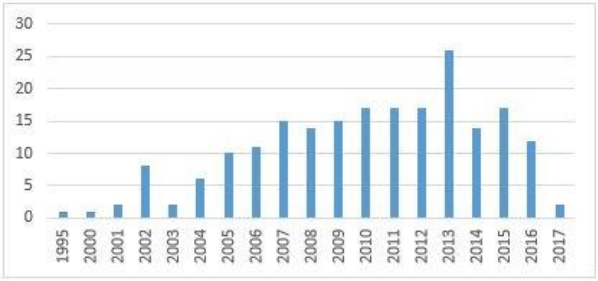

Table 1: CISSP Annual Article Distribution

The 207 articles were published in a wide range of 122 different journals. As expected, many of the journals were computer related, but not necessarily security related. There were, however, several that were not specifically computer related, such as the International Journal of Logistics Management, which was in the top eleven journals by article count – tied for number nine with two others. Table A-1 in the Appendix shows the top eleven journals by article count. *The Journal of Digital Forensics, Security and Law* led the list with 13 articles.

There were 108 articles with at least one author being a CISSP and 109 articles about CISSPs. This total of 217 and reflects that some CISSP authors also wrote about CISSP topics. There were only 19 non-CISSP authors who wrote papers specifically about CISSPs, leaving 80 articles where the CISSP was only mentioned in passing and the CISSP contribution was negligible. These "in passing" articles have been removed from the remaining analysis.

Surprisingly, only about half (59) of the articles written by CISSPs deal specifically with Information Security. Many are on other topics or industries. Table 2 shows the top industries represented by CISSPs as authors. In addition to the top industries, a column for editorials has been included as there were several represented in the articles by CISSPs. All 19 of the non-CISSP authored articles were specifically about Information Security and are not represented in Table 2.

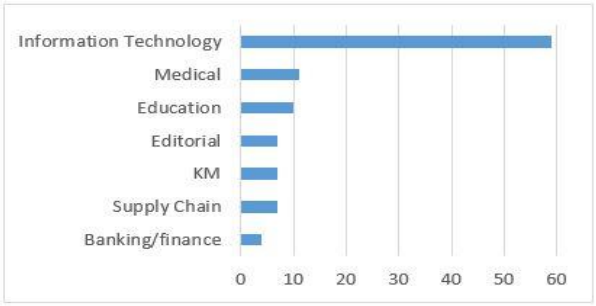

Table 2: Industry Count

There were quite a few different topic areas represented by the articles found. As expected, Information Security was the largest area, with Education and Risk Management the next popular. Table 4 shows the distribution of topics for the combination of CISSP and Non-CISSP Authors. Please note that there is some overlap between topic areas as the focus of a paper may be on Information Security AND Education Security. Also note that ALL articles represented in Table 3 are based off the Security contribution, so there are fewer in Education and Medical than are represented in Table 2, which includes Medical and Education, but not necessarily overlapping with IT Security. For the Non-CISSP authors, the most popular topic area was in Education Security, followed by Interviews.

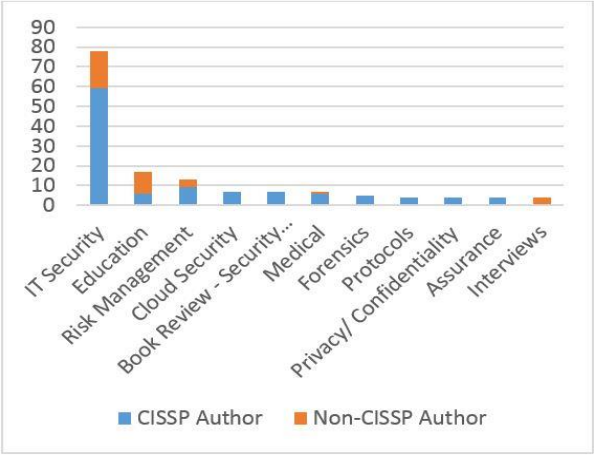

Table 3: Security Topic Count

As seen in the previous charts, CISSPs write about a variety of topics, many of which are not related to Information Security. An analysis of who writes what is needed. The 108 articles by CISSPs were written by only 77 different authors. 65 (84%) of the authors have only a single article with the CISSP certification listed as a credential. 51 (66%) wrote at least one Information Security based article. Table 5 shows the top seven authors based on total number of articles and total number related to Information Security. Of

the top seven, only Author 5 wrote solely on Information Security.

Table 4: Article Count by Author

3. CONCLUSIONS

This study has attempted to quantify various aspects of research about and by CISSPs as represented by the academic body of knowledge. There are two notable limitations to the study. The first is that not all authors with CISSPs include that credential when publishing their work, which will lead to some articles remaining undiscovered. The second limitation is the database selection. The collections used are not all-encompassing and there could be works published by or about CISSPs in other sources.

In spite of the limitations, this study has provided some valuable insight into the contribution of the CISSP in academic research, both from an author perspective and as a topic for research. Two things stood out to the author about the findings of this study. The first is the surprising percentage of CISSPs who are NOT publishing Information Security related studies. It is understood that many academics have multiple areas of interest; however, it was a surprise to find that nearly half 45% (49/108) articles by CISSPs were not specifically security related. On the flip side, with 66% of the CISSP authors writing at least one security related article, the representation is not all bad.

The second notable finding is the flatness of the article by year progression. As information security comes more and more to the forefront and the number of CISSPs in academia increases, it would be expected for articles by and about CISSPs to continue to rise in number. In fact, the opposite seems to be true as the numbers for 2016 show a marked decrease in quantity of CISSP articles. It is hoped that this paper might encourage more discussion and articles about CISSPs in Higher Education.

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APPENDIX

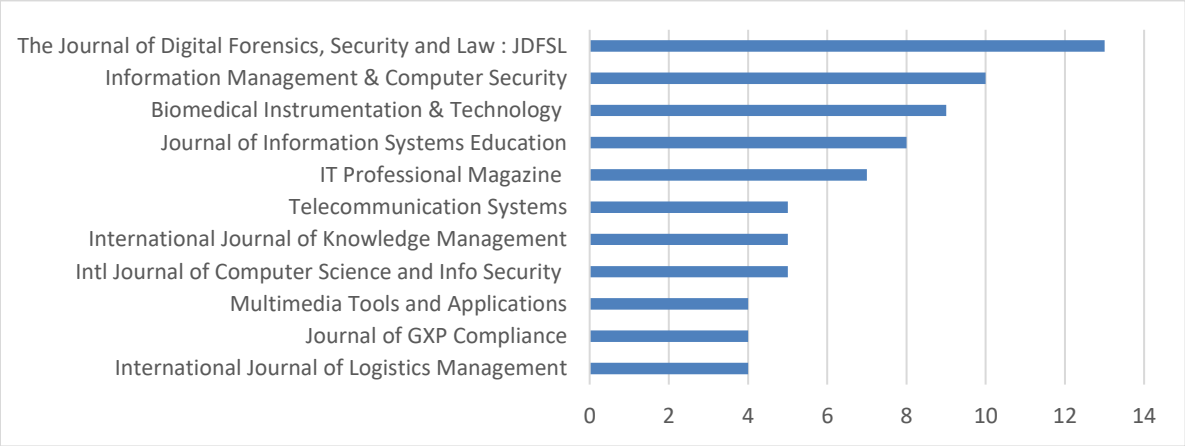

Table A-1: Article Distribution by Publication