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Pandemic Shift: Impact of Covid-19 on IS/Microsoft Office Specialist Excel Certification Exam Classes: Remote Testing and Lessons Learned

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Abstract

The corona virus (Covid-19) caused serious havoc on society impacting all industries resulting in major changes in business practices, operations, and policy. In the case of academia, at a moment's notice, all universities that used face to face instruction were forced to move to an online format and make serious modification to successful courses. This paper documents a successful certification course structure and reports the experience and results of moving that course in Excel comprehension (certification) from traditional face to face to online. In addition, this paper provides a discussion into the strategies used for remote testing and teaching. Overall, the Covid-19 sections were not as successful as previous traditional sections. This paper concludes with lessons learned that can be helpful for future remote or online course deliveries.

Keywords: Covid-19, Remote Testing, Certification, Microsoft Excel, Analytical Skills, Pedagogy, GMetrix SMS

1. INTRODUCTION

On March 15, San Diego only had 8 positive cases and the rest of the nation were still having debates about the seriousness of the Covid-19 virus. At that time, many universities moved classes to a remote/online delivery method in preparation of lockdown and stay at home orders. By April 2020, the virus was full blown and saw the start of monumental change in higher education across the United States. On March 19, the state of California announced a stay-at-home lockdown order for 21 days. As shown in Figure 1, the entire United States became one of the 188 countries in the world that shut down all schools or localized them in some cases to avoid the spread of the virus while affecting 1.576 million children and youth affection the 91.3% of the world's student population by April 04, 2020 (Basilaia & Kvavadze, 2020). For the year of 2020, the country has 14.3 million students in public colleges and 5.12 million in private colleges (Statista, 2020). Out of the 5,300 institutions in the USA, there are 1,626 public colleges, 1,687 private nonprofit schools, and 985 for-profit schools.

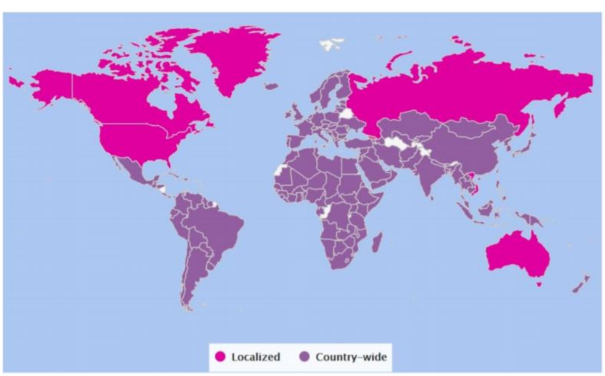

Figure 1 Countries that have shut down or localized schools in the world UNESCO Report

The pandemic has created a situation where students cannot go to school. Covid-19 has certainly forced almost all institutions to adapt extremely quickly, particularly in the area of moving to online education (APLU, 2020). This move caused universities to consider other factors such a technology hardware and bandwidth. Technology companies such as Zoom and Microsoft offered free use of the digital conference programs for classroom and meeting uses. Almost overnight all faculty and students were having to learn and adapt to new ways of classroom expectations and training.

Moving to remote instruction was easier for some areas, particularly those areas where learning was dependent upon synchronous human interaction. Thus, the features of the online format varied with the different type of subject matter.

On first impression, computing instruction would be considered to be a no-brainer decision for moving to remote. This is because many computing concepts could be taught asynchronous at any time. However, computing concepts and more specifically application training are more effective when students can have physical real-time one on one synchronous sessions.

The purpose of this paper is to communicate how Covid-19 has changed the delivery of our successful certificate classes. The paper is structured as follows. First, is a background discussion on the value of certification followed by the framework that compromise an entry level information systems courses that has a strong Excel certification requirement. Second, is a discussion of the performance of previous offerings followed by a dialogue on how Covid-19 and remote/online learning impacted the class. This area specifically examines the introduction of remote testing and some of the teaching strategies that had to be employed in the online synchronous environment. The paper concludes with comparing the results between Covid-19 and pre-Covid-19 classes and providing lessons learned to be applied to future courses.

2. BACKGROUND

Technical proficiency is a desired or expected outcome of information systems. The concepts of an information systems (IS) course form the foundations of technical literacy which leads to information competence. Technological literacy is essential to compete in today's economy (Bakir & Dana & Abdullat, 2018). The ability to understand, use, and manipulate data to make decisions is an essential factor of information competence (Mandinach & Gummer, 2013). One way for determination or validation of competency is to create skillset exams that when passed earn the student a certification. In other words, Certification is a method of estimation of an individual's expertise via a standardized measurement instrument (Perks, 1993). These programs have been and continue to be popular among business and computer information systems programs. Certifications have a significant effect on the employability of employees (Carnevale, Rose, and Hansen, 2013; Claiborne, 2017; Hunsinger & Smith, 2009). Other research has shown employees feel there is a gap in technical skills (Lim, Lee, Yap, and Ling, 2016) that needs to be addressed by academia.

Certifications are one solution and these certifications also prepare students to compete in competitive job markets and showcase their marketability while they are still in school. Bartlett, Horwitz, Ipe, and Liu (2005), reported that certifications do play a role in hiring decisions. Based on the Pearson VUE Value of IT Certification survey (2019), findings showed employees benefitted from acquiring a certification. For example, 65% of the employees indicated a positive impact on their professional image, 35% received a salary increase, 28% received new job responsibilities a job, and 26% received a promotion.

The Microsoft Office Specialist (MOS) exam was selected because results of studies concluded, that 67.5% of participants believed that they benefited by having the certification and 56% answered that MOS certifications did, in fact, help them gain employment (Tarver, Tarver, Varnardo, and Wright, 2009). Excel was selected in our program as the certification vehicle because many of the upper division courses used the program, and because Excel MOS certifications were valued most positively would likely influence employers to hire a candidate (Claiborne, 2017). Researchers (Bakir, Dana, and Abdullat, 2018) have noted that advanced analytical skills, Excel, in particular those taught by MyEducator (MyEducator, 2020) result in increased marketability and increased compensation for graduates (Formby, Medlin, & Ellington, 2017). General knowledge of Excel that students may obtain outside of the classroom is no longer sufficient. Over 80% of business students claim their goal is to get a good paying job, and many businesses are requiring advanced Microsoft Excel skills (Formby et al., 2017). Furthermore, AACSB has also indicated a shift towards relevant skills such as Microsoft Excel in hiring of business school graduates (Gomillion, 2017).

Many colleges and universities have implemented MOS certification programs into their curriculum with success. Certiport (2020) highlights higher education success stories with very positive outcomes. Certiport' website reports how Troy University's MOS program enhances work skills leading to greater career success. They discuss how Bellevue program increased student satisfaction and job opportunities and how Northern Iowa MOS program validates student skills for professional development. Perhaps most relevant example was a special Certiport highlight (2020) on the University of Denver Daniels College of Business program as that university is very similar to the university where this study took place. Certiport (2020) highlighted how implementation of MOS Excel improved student performance, enriched recruiting power, improved student placement, and expanded the program.

3. DESCRIPTION OF COURSE PRE-COVID-19

Our Introduction to Information systems is unique because it has a strong IS managerial concepts component along with covering the full Microsoft Office Suite. The information systems management concepts section focuses on IS competitive advantages, IS security, networking, database, enterprise resource planning, electronic commerce, supply chain, customer relationship management, emerging IT topics (cloud computing, artificial intelligence) and ethics. The students engage in a lecture exam on concepts as well as assignments, and is in addition to the MOS exam.

While we cover the other three main MS Office suite products (Word, PowerPoint, Access) we place a heavy focus on Excel. Our Introduction to Information systems course has offered the Certiport program since 2012. It started off with just one pilot and now we offer10-12 sections of the course each semester all of which require MS Excel certification (MOS). The MOS consists of three levels: Specialist, Expert, and Master. The Specialist is the exam selected for the Introduction course and we offer the Expert and Master for upper division courses. The MOS certification measures and validates Excel core skills in five topics: (a) create and manage worksheets and workbooks; (b) manage data cells and ranges; (c) create tables; (d) perform operations with formulas and functions; and (e) create charts and objects.

The Introduction to Information systems course is open to all undergraduates without any prerequisites, however it is required for all business majors. Lately, the course has been very popular with communication majors. The course utilized the Introduction to Information Systems by Rainer and Prince (Wiley) for IS lecture concepts, my educator for Excel assignments, and GMetrix for MOS preparation. MyEducator is an online textbook with interactive lessons and modules on Microsoft Excel and Microsoft Access. The students are responsible for purchasing the Wiley textbook and MyEducator. Gmetrix and the MOS voucher are covered by a student fee. The university is an authorized Certiport testing center and handles the proctoring.

GMetrix Skills Management System (SMS) is a practice exam engine, which is authored by GMetrix LLC, "a provider of educational tools designed to prepare individuals for the effective use of technology in the business environment" (GMetrix 2020). Tastle, et al, 2017, describes the GMetrix SMS as containing six exam "modules" that help prepare students for the certification exam. The first three are referred to as "Core Test" modules and the remaining three are referred to as "Core Project" modules. Each set of three increases in complexity. Additionally, each exam module may be taken in "training mode," which allows students to complete the module in their own time and which provides direction for the students to correctly answer the question, and "testing mode," which is timed similarly to the actual certification exam and no help or direction is available. "Core Test" exams are delivered in question-answer format, while "Core Project" exams are a set of cumulative instructions intended to produce a finished product, which is then graded. The "Core Project" modules very closely mirror the actual exam (which is also delivered in project format) so that students are comfortable with the Microsoft exam interface and know how to work the keyboard. One can even make customized exams or homework assignments in Gmetrix. As students practice their skills on these tests, they build confidence, enhance their learning, and become familiar with the testing environment prior to the actual exams (Bakir, Dana, and Abdullat, 2018).

This course has the students work on approximately 9 homework assignments in MyEducator (6 Excel and 3 Access) and 3 specialized assignments. As previously mentioned, one can create custom assignments and tests that are specific to each student strengths and weakness. The course employs a pre, mid, and post assessment of Excel abilities both in testing and via Likert survey questions. There are also 3 individual class sessions dedicated towards training/testing of the MOS. The first session utilizes a GMetrix Core Project exam in training mode where students can use the help feature and are only limited by the time of the class. The second session has the students taking another exam with the ability to use help and they are forced to submit after a 50-minute time limit. The third session mirrors the actual MOS examination environment where the students take another different exam that is timed and there is no help available. Each practice exam session has a point value that aggregates with each session and the final MOS exam has a weight of 25% of the course grade. In the event the student does not pass the exam on their first attempt, they are allowed a second opportunity, however there is a max score of 80% allowed regardless of their second retake performance.

4. PRE AND POST COVID-19 RESULTS

Overall, the results of our class structure, pedagogy have been very successful as shown in Table 1. There was one anomaly in Fall 2016 where the scores dropped considerably. Exam question review, scores and testing equipment (coding) were analyzed to determine exact causation and were to no avail. Other efforts to contact Microsoft regarding error detection and correction went unanswered. The prevalent consensus is that in Fall 2016 Microsoft changed their exam format from a series of 1 item question tasks to a two-page, four-part interdependent project. This exam did allow for a reset function, however doing so was a complete reset as compared to the previous MOS version where only 1 question/task was reset. Also, the expert exams were considerably more challenging and different because one had to take

2 separate exams to prove competency. Subsequently, in Spring of 2017 a new revised project format was unveiled, which is the 7 different five-part mini project exams that is still being used. The reset function now only applies to one specific project as compared to the entire exam.

Excel Exam Results 2016-2018

	*F16****	*SP16*	*F17*	*SP17*	*F18*
% PASSED	85%	92%	93%	95%	95%
% FAILED	15%	8%	7%	5%	5%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**
*** new version of MOS exam introduced/had issues corrected					
Result breakdown					
PASS 1st Take	62%	81%	77%	83%	85%
FAIL 1st Take	38%	19%	23%	17%	15%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Table 1 Excel Exam Results 2016-2018

Midway through the Spring 2020 semester the university was shut down under a state mandate lock down order and the rest of the courses were delivered remotely through synchronous Zoom sessions. Table 2 and Figure 2 show the percentage difference in MOS performance due to the Covid-19 changes in instruction. Overall, there was a substantial percentage decrease in first and final pass results between the two semesters. There was also a large number of students not passing (6 more) in the covid semester than in the non-covid spring 2019 semester.

MOS RESULTS	SP19	SP20	DIFFERNCE
FIRST RESULT PASS	**87.2%**	**74.0%**	**-13.2%**
FIRST RESULT FAIL	*12.8%*	*26.0%*	*13.2%*
FINAL RESULT PASS	**96.9%**	**87.2%**	**-9.7%**
FINAL RESULT FAIL	*3.1%*	*12.7%*	*9.6%*

Table 2 MOS Comparison Results 2019-2020

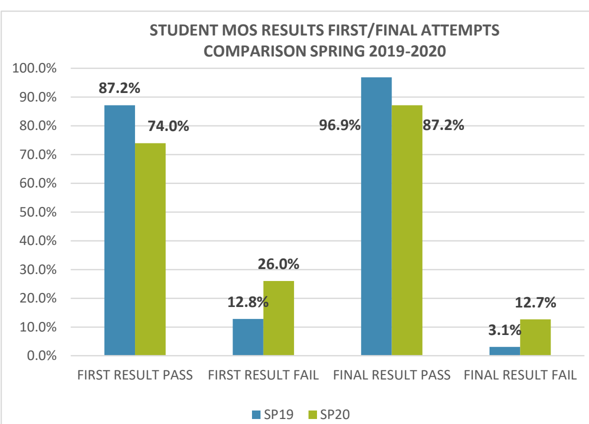

Figure 2 Student MOS Results SP 2019 versus SP 2020

The course also measures the students' knowledge of IS concepts. This is evaluated by a pre and post survey where the students self-evaluate their understanding, comprehension, and ability of several IS concepts. There was a percentage decrease in knowledge comprehension in most areas and the results are shown in Table 3 and Figure 3.

TERM	SP19 INCREASE	S20 INCREASE	DIFFERENCE (+/-)
COMPUTERS	22.4%	16.2%	-6.2%
WORD	21.0%	13.4%	-7.6%
EXCEL	77.4%	64.6%	-12.8%
ACCESS	148.2%	82.4%	-65.7%
POWERPOINT	28.8%	11.5%	-17.3%
WEB	23.8%	13.1%	-10.6%
HTML/CREATE	54.9%	87.7%	32.7%
NETWORK	70.5%	93.2%	22.8%
INFO SYS	87.5%	95.4%	7.9%

Table 3 PRE-POST Increase/Decrease of IS Concepts Knowledge

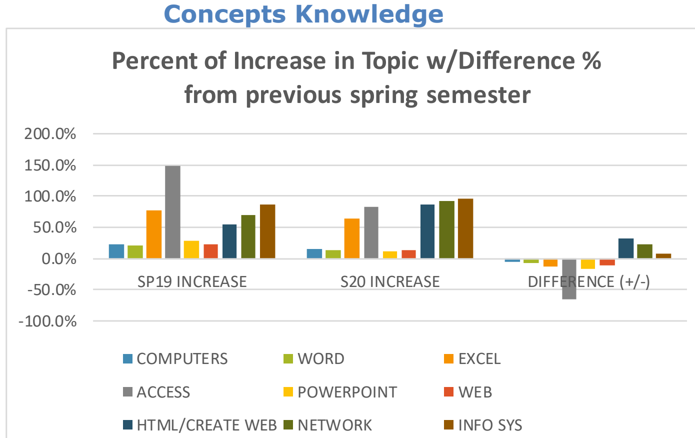

Figure 3 Visual Representation of Topic Differences

Lastly, there was a considerable difference in grade distribution and is shown in Table 4. Interestingly enough there was about the same number of A's and slight increase of C's, and a substantial difference in the B and D/F category.

Grade Distribution Comparison 2019-2020

Grade	ITMG 100 SPRING 19	ITMG 100 SPRING 20	Differece
A+, A, A-	25.80%	25.60%	-0.20%
B+, B, B-	54.80%	23.30%	-31.50%
C+, C, C-	9.70%	18.60%	8.90%
Combined D/F	9.70%	32.60%	22.90%

Table 4 Grade Distribution Comparison 2019-2020

5. DISCUSSION

As the different tables and chart indicate the Spring 2020 offering had much different results than the previous Spring as well as for most of the other semester offerings. Granted there was a significant amount of unrest and disruption in delivery and mental state that could explain a fair amount. However, this occurred in the middle of a 15-week semester and there was a large amount of resources made available to students to address their mental, emotional, and health needs.

One of the largest disruptions was the testing environment of the MOS exam. Thankfully, Certiport was able to provide exams and home service. This solution was unique and new as it allowed for a student to take the MOS exam at home, regardless of platform (MAC, PC, Chromebook). The setup procedure was simpler than creating a lab with Compass as the students could be assigned in blocks of 10, or they could arrange to have an individual appointment. During this particular semester the program was so new that Certiport was encouraging the block of 10, where the instructor would receive the URL exam link the evening prior. For the individual sessions, the URL are sent 1 hour prior to exam start time, although the appointment time is confirmed a few days prior to exam. This system worked relatively well though it did have drawbacks. The sessions were supposed to have a virtual proctor and in some cases the technology did not work. In addition, invariably there were technical issues with the exam delivery or in the process that caused the students to have to retake the exam. Unfortunately, there is no way to measure how prepared a student may have been or what their performance would have been if their exam had not been shut down. There is also no way to measure the increase in confidence or decrease in text anxiety that an instructor who proctors their own test can provide.

Another challenge was that majority of the students have MAC computers so they relied on the classroom, computing lab, or library to practice and complete their GMetrix. Actually, because the GMetrix only works on a PC platform, this reliance becomes mandatory for those students who only have Apple Macs. A remedy virtual machine software solution was created towards the end of the semester. We set up a site license for VM Fusion and Windows OS 10 for the students to install and load on their computers. Installation manuals, FAQ, videos, and personal sessions were created and a few students participated.

It is presumed that the lower scores in the MOS, the grades, and course comprehension is related towards the remote online delivery. While the courses were delivered synchronously at the regular scheduled time, many students decided to rely on the Zoom recordings. Zoom logs do provide some indication of number of access attempts, yet the data is not more robust than that. For example, it is not known how long they are watched, or how often the person skips around.

The Zoom sessions themselves present a challenge when one person is struggling with a technical Excel concept. Zoom allows for the ability to share screen and sometimes those who are already past the task or understand the problem find themselves frustrated and bored while the struggling student tries to keep up.

6. LESSONS LEARNED

One concept learned through several years of administering the MOS program is that things change and performances will vary. Fall 2016, saw the introduction of a new test and format, which over time, changes and adjustments to the schedule, assignments, and delivery led to previous if not higher level of results. The same can be said of transitioning the MOS exam and class from traditional face to face to remote/online. One of the main purposes of this paper is to provide some of the lessons learned in case future courses need or want to transition.

Lesson 1

Make certain students have access to a PC operating system with MS Office to run GMetrix. Our VM Fusion solution is feasible and does have challenges. It is hard to accommodate a large number of students particularly since the installation can vary per computer. We recommend having your university create a remote desktop program where students can log in and use cloud computing regardless of their own personal device. We petitioned our university and they created a system call guacamole (see Appendix). It compromises of different computer labs thus allowing for a wide range of software and not just MS Office.

Lesson 2

Read and register, so you can proctor your student's MOS Certification "Exam at Home" (https://certiport.pearsonvue.com/Educator-resources/Exams-from-

Home/ExamAdministrator_Exams_from_Home_ SelfService.pdf). This way you can be part of the testing experience as opposed to providing a link to the student and waiting to hear the results. It will decrease the test anxiety for the student. In addition, in the event of test malfunction you would be able to provide reassurance that it was not their fault, thus helping to keep their confidence level intact.

Lesson 3
Require attendance for any online sessions that are held in Zoom. Do not make the Zoom recordings publicly accessible even in student Blackboard or Canvas. Instead, keep the recordings and make them be available upon request. For even stronger assurance of material comprehension you could require a one-page video report from the student that summarizes the session.

Lesson 4
If possible, have an extra monitor and move struggling students to a breakout room while keeping an eye on the rest of the students in the main room. Better yet, create a breakout room and have a couple of students go to the room to work it out. In our classes, we seek to determine technical ability and pair stronger and weaker students together. This method allows for the stronger student to become more engaged when assisting the struggling student. If it is not possible to have an extra monitor or breakout room, one could have the struggling student perform the activity along with verbal commands from the instructor.

Last Lesson
Conduct midterm evaluation surveys and monitoring of grades. Keep attendance and participation records. The digital Zoom cannot replace the physical distance or the lack on real life in person interpersonal interaction. Thus, using other analytical tools can help provide warnings and clues to those individuals whose attention might be waning.

7. CONCLUSION

The main purpose of this paper was to convey the results and impact of Covid-19 on a successful IS class and MOS Certification Program. The transition from traditional face to face to remote/online was very challenging and many lessons were learned. This paper properly documents the experience as well provides insights for those who might have to make the conversion in the future. Course delivery, like life, is a journey and not a destination and more research and investigation are needed as the modes of course delivery and student learning continue to change.

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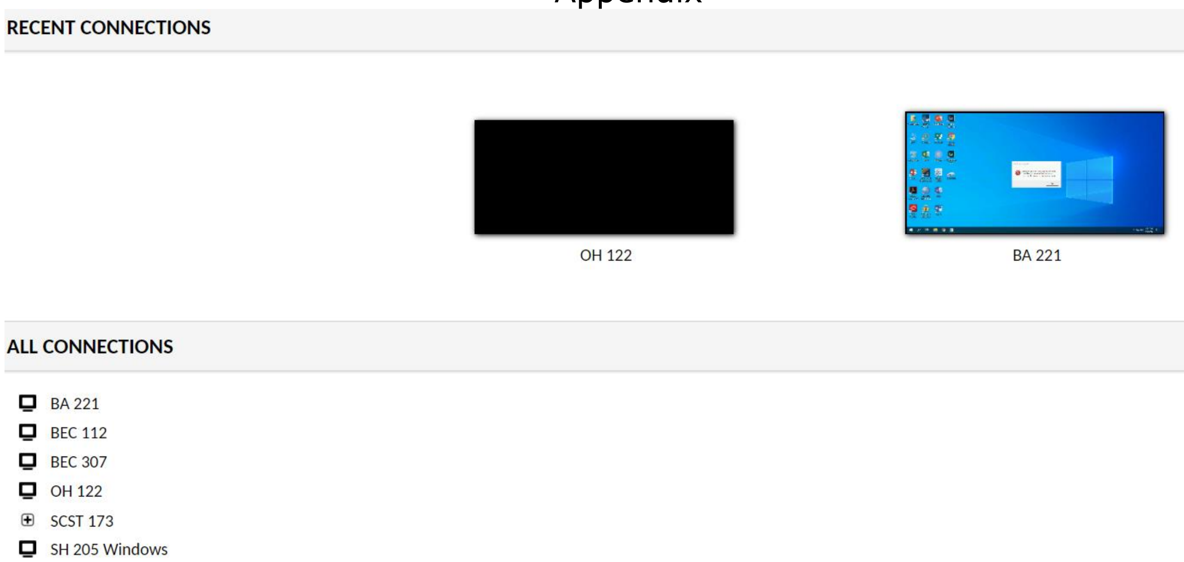
Appendix



Guacamole Remote Desktop

An Investigation on Student Perceptions of Self-Regulated Learning in an Introductory Computer Programming Course.

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Abstract

Learning how to become a self-regulated learner could benefit students in introductory undergraduate courses, such as computer programming. This study explores the perceived value of instructional and skill-building activities and students' self-efficacy to learn and apply programming skills in an introductory computer programming course. The instructional activities include code-demos through which the instructor demonstrates several cognitive strategies for self-regulated learning. Four different skill-building activities accompanied by Q&A sessions let the students model the teacher's practices, and apply various self-regulated learning methods to strengthen their programming skills. Surveys are implemented and analyzed to learn the students' perceptions of the task value of skill-building activities and the Q&A sessions and their reported self-efficacy for independent mastery, problem-solving, correcting errors, and experimenting with programs. Studies revealed that the perceived ability to master programming independently is significantly correlated to the perceived task value of activities that required students to complete programs similar to the instructor's code-demos. Students who report a higher self-efficacy for problem-solving also positively value the Q&A sessions through which they obtain help from the instructor to complete tasks on pre-written codes.

Keywords: Computer-programming, Self-Regulated-Learning, self-efficacy, problem-solving, teaching, learning.

1. INTRODUCTION

Introductory computing courses are generally regarded as difficult and often see many dropouts that lead to attrition (Kinnunen & Malmi, 2006). According to (Beaubouef & Mason, 2005), most attrition occurs during freshman and sophomore years. Studies have also shown that students often do not acquire good practice as they complete their introductory computing courses (Lister et al., 2004). One approach to increasing success rates in undergraduate computer programming courses is teaching students how to become more effective self-regulated learners who will apply deliberate practice to improve their programming skills.

Self-regulated learning (SRL) is an active process in which the learners take significant initiative in their learning process and persevere by continually adapting to the tasks at hand (Zimmerman, 2002). They set learning goals, monitor their goals, and regulate their cognition, motivation, and behavior to achieve their set goals (Pintrich, 2004).

A key determinant of whether learners employ SRL depends on the beliefs about their capabilities (Cleary& Zimmerman, 2006). SRL strategies and beliefs of self-efficacy to do a particular task are interdependent; both require the presence of specific cognitive capacities, such as the ability to set goals, self-monitor, reflect, and make judgments. More importantly, both also support personal agency or control. Students' academic self-efficacy is related to motivation and academic achievement (Komarraju & Nadler, 2013). Self-efficacy combines judgments of one's ability to accomplish a task, confidence in one's skills to perform a task, and expectancy for success in the task.

Another motivational factor that positively impacts SRL is the learner's task value (Pintrich, 2000) (Pintrich & Zusho, 2002). A student can perceive a task as valuable based on its perceived utility, importance, or interest.

Improving students' self-efficacy in learning through SRL strategies could significantly benefit students in an introductory computer programming course (Bergin et.al, 2005). The majority of learning in a computer programming course occurs outside the classroom, as it involves hands-on practice in problem-solving, writing, compiling, and testing computer programs. However, many college students do not know how to effectively self-regulate their learning process (Bembenutty, 2008). First-year students often rely on their teachers' support during secondary schooling to direct their learning processes (Chemers et.al, 2001). Therefore, many freshmen students find it challenging to engage in self-directed learning that requires repetitions of planning-practice-and-reflection cycles.

This study explores the value of various instructional and skill-building activities that can teach some of the critical self-regulated learning strategies required to master computer programming. This study's context is an undergraduate level introductory programming class of 22 students in a computer information system program at a public university. This study considers an instructional approach that models the instructor's practice of applying the SRL process during a programming demonstration and Q&A sessions. Additionally, this study also considers four different skill-building activities through which students get an opportunity to emulate the instructor's practices to solve programming problems and develop critical skills.

This study attempts to find the correlation between the student perceptions of the learning activities' task value and the reported self-efficacy for independent mastery, problem-solving, correcting errors, and experimenting with programs.

2. RELATED WORK

This study assumes that learning computer programming practice occurs as a cyclical exchange of knowledge and information between the learner and an external learning environment. Besides the learner's interaction with external agents, a learner goes through an internal process that regulates the thoughts and actions within the learner's mind. A Self-Regulated-Learning (SRL) model is used to identify various steps in a learning process.

2.1 The teaching-learning model

For this study, the learner's interaction with the learning environment is assumed to occur in two ways; 1) between the learner and the teacher, and 2) between the learner and an external learning tools such as an Integrated Development Environment (IDE). These interactions may be termed as the Teacher-Practice cycle and the Teacher-Modeling cycle, respectively (Laullilard, 2012). The Teacher-Practice cycles involve interactions in which the teacher demonstrates the ideal way to practice a skill and provides useful feedback to the students to improve their skill. On the other hand, the teacher-modeling cycle allows the student to independently model the teacher practices and involves an interaction between the learner and the learning tool, which in this study is the IDE. Teacher-Modeling cycles influence the learner's abilities to engage in independent and deliberate practice to improve programming and problem-solving skills. The IDE provides immediate feedback to students and provides opportunities for students to engage in repeated practice and self-regulated learning. Although there might be several relevant interactions among the learners, which are beyond this paper's scope.

In a programming course, the Teacher-Practice cycle typically consists of code-demonstrations and Q&A sessions used to discuss coding and problem-solving practices. The Teacher-Modeling cycle is enabled through skill-building problems that require the use of an IDE to implement solutions. A teacher may provide additional feedback and support through regular Q&A sessions to help students understand and apply appropriate actions based on the IDE feedback.

2.2 The Self-Regulated Learning Model

Self-Regulated-Learning (SRL) is a research area under which many variables that influence learning, such as self-efficacy, volition, and cognitive strategies, are studied within a comprehensive and holistic approach. A meta-analytic study of SRL identifies various models that researchers can utilize to suit their research goals better and focus (Panadero, 2017). This study draws from previous studies on SRL that posits that Self-regulated learning can be taught (Pintrich & Zusho, 2002). SRL strategies can be transferred to students through instructions specific to the learning context (Perels, Dignath, & Schmitz, 2009). These studies show that providing direct instructions on specific strategies and using the right learning environment can enhance students' self-regulated learning.

This study's SRL model is derived from Zimmerman's work (Zimmerman & Moylan, 2009). Zimmerman's SRL model is organized into three phases: forethought, performance, and self-reflection. In the forethought phase, the students analyze the task, set goals, and plan how to reach them.

Students execute the task in the performance phase as they monitor their progress and use self-control strategies to keep themselves cognitively engaged and motivated to finish the task. Finally, in the self-reflection phase, students assess and understand the factors that might have impacted their success or failure. The self-reflection phase generates reactions that can positively or negatively influence how the students approach the task in later performances. Zimmerman's cyclical phase model has been tested in a series of studies. Studies that compare experts and non-experts in sports show that experts performed more SRL actions (Cleary & Zimmerman, 2001) (Cleary et al., 2006).

Zimmerman's three-phase SRL model could be applied to model the learning process in a computer programming course. Students need to analyze the task requirements in a programming course and continuously monitor their code to find errors before arriving at an acceptable programming solution. After completing a task, it would help the students reflect on their coding habits and practices to improve their performance. By providing students with suitable instruction during the Teacher-Practice cycles, the teacher can model different ways by which students may monitor their practices. Students could apply these learning strategies to take control of their learning during the Teacher-Modeling cycles.

Previous studies have examined the role of self-regulation within the educational context of computer programming (Bergin et al., 2002) (Kumar et al., 2005) (Chen, 2020) (Ramirez et al., 2018).

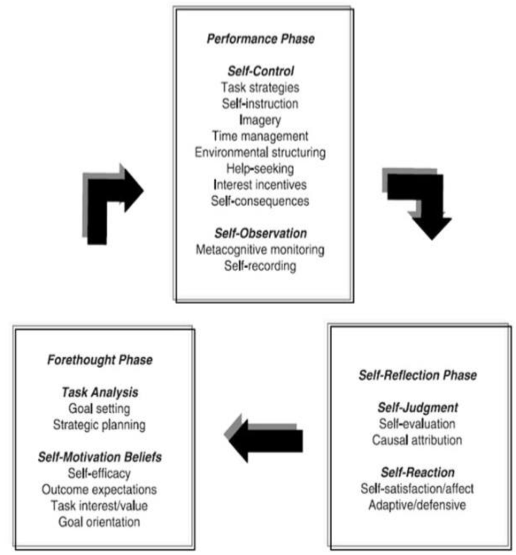

Figure 1. Zimmerman's Self-Regulated-Model (Zimmerman & Moylan, 2009)

These studies' focus has been to evaluate the impact of self-regulated learning strategies on students' coding performance. Another study by Castellanos et al. uses students' source code to study student motivation, performance, and learning strategies (Castellanos, 2017). Unlike the two studies mentioned earlier, the study described in this paper evaluates the perceived value of teaching and learning activities and the self-efficacy required to learn and practice programming through a course that instructs cognitive strategies for self-regulated learning through the course contents. This study focuses on students' self-efficacy and not on their measured or reported performance in the course.

Extensive recent work on SRL exists in building online, adaptive learning systems with open-learner-models (OLMs) that allow learners to visualize and inspect their progress during the learning process. It has been pointed out that OLM can support metacognition and self-regulation (Bull & Kay, 2013). Moreover, researchers have incorporated OLM in all phases of self-regulation, i.e., preparation, performance, and appraisal, and in the areas of cognitive, metacognitive, motivational, and emotional support (Hooshyar et al., 2020). For example, OLM has been used to improve self-assessment accuracy through dialog-based support (Suleman et al., 2016) and improve engagement in a programming course (Hossieni et al., 2020). All these studies were performed in full-online learning that does not include any teacher's direct intervention during the learning process. The study described in this paper models a typical freshman-level, under-graduate classroom scenario. The teacher still plays a central role in mediating students' self-regulation strategies. Therefore, this paper's focus is on a teaching-learning model that includes the central role of a teacher in designing and supporting the learning process by adapting to the learners' needs.

3. THE DESIGN APPROACH

The instructional design evaluated in this study incorporates teaching strategies for the Teacher-Practice cycle and suitable learning activities for the Teaching-Modeling cycle. The teaching methods are chosen such that they incorporate the three phases of Zimmerman's SRL model.

3.1 Designing the Instructional Activities

The teacher-practice learning cycle consists of activities through which the instructor, who is also an expert programmer, models the programming practices. Table 1 shows the instructional activities in the Teacher-Practice cycle. Code-demonstrations (code-demos) explain the programming process through task analysis, code development, execution, and testing. The sample code used for the code-demo contains extensive documentation and comments that students can refer to later on.

The forethought/planning phase of the code-demo typically includes a detailed explanation and analysis of the problem statement to identify the functional and data requirements. These planning activities are written down as part of the code documentation in the code's comments section. The instructor may use real-world examples to show the value of the problem. The instructor will then teach students to identify the problem's inputs and the expected outputs, create a test plan, and search for similar problems that use similar programming structures.

The code-demo's performance phase typically involves the instructor elaborating on the systematic thought process required to write the program sequences. The instructor encourages extensive use of comments next to the code statements. Students also observe how the instructor applies techniques such as tracing the variables or printing out the variables' values to test and incrementally build their code.

	Instructional activities - Teacher-Practce Learning Cycle		
	Forethought	**Performance**	**Self-Reflection**
Code Demos	Problem Analysis, Solution planning, Reviewing Test Plans	Choice of constructs, Identifying right sequence, Tracing variables, Running Tests	Evaluating Style & Practices and Errors
Q&A Sessions	Task planning , Goal Setting for the class	Discussions on Identifying and correcting errors; adopting good practices	Choosing practice materials to strengthen practice

Table 1. Instruction Activities – Teacher-Practice Learning Cycle

The self-reflection phase of each code-demo is used to analyze various options for accomplishing the same outputs. The instructors discusses acceptable coding practices that are relevant to the problem. The instructor also highlights the challenges commonly encountered while solving the problem and improve their problem solving and programming skills.

Integral to the Teacher-Practice learning cycle are the Q&A sessions. The Q&A sessions are conducted during the regular class session after students get adequate time to complete learning activities. These activities are described in Table 2. During the Q&A sessions, the instructor would clear any misconceptions or problem-solving difficulties students would have experienced while completing a learning activity. The instructor may also discuss the graded assignments and some of the common errors and misconceptions that would have appeared in student submissions.

3.2 Designing Practice Exercises

The Teacher-Modeling cycle follows the Teacher-Practice cycle. Students learn to apply the teacher's program development practices previously explained through the code-demos. Through shorter practice problems, such as the Test-Tube, Hack-the-code, Messed-up-code, students practice essential programming skills that could be used to develop larger programs.

The Do-It-Yourself (DIY) exercises are more time-consuming activities that students complete at home. These activities contain problems that are analogous to the ones explained during code-demos. By observing the sample code provided during the code-demos, students can recollect and emulate the practices of the instructor and apply all three phases of SRL to document and write the code by themselves using an IDE. The

DIY activities also advise students to analyze the problems and the test plan, write extensive comments, and incrementally build their code. A sample DIY activity problem is shown in Appendix B.

Activity name	Practice Exercises - Teacher-Modeling Learnng Cycle
DIY	Try out every code-demo independently, following the instructor's comments/explanation.
Test-Tube	Test a given code by varying the inputs,or by making suggested changes to obtain a given output
Messed Up Code	Analyze an errored-code
Hack the Code	Experiment with a given code to produce a set of outputs (including errors)

Table 2. Type of Practice Exercises – Teacher-Modeling Cycle

As they learn to write programs, novice programmers generate programming errors, and they need to learn how to identify the cause and correct these errors. Many students require help to understand the types of errors and on how to recall their previous troubleshooting experiences to improve their programming skills.

The instructor developed activities called Hack-the-code and Messed-up-code to help students gain practice and become comfortable with detecting and correcting logical, syntax and runtime errors. The Messed-up code contains one or more errors that students need to identify and correct. Hack-the-code is an activity in which students need to alter a pre-written code's logic to obtain the required set of outputs. The Messed-up code and Hack-the-code activities intend to encourage students to feel comfortable in experimenting with their code. Another activity that encourages students to solve problems by experimentation is the Test-Tube activity. This activity requires students to develop and execute a test-plan for a given code and, in most cases, also requires them to trace the variables. All these activities intend to teach cognitive and meta-cognitive strategies that improve coding practice. Appendix B contains Samples of Hack-the-code, Test-Tube, and Messed-up code activities.

The learning activities let students work on the problems by themselves and learn how to ask for help from their peers and instructor. Students are encouraged to apply the three phases: task analysis, performance monitoring, and self-reflection for every task they perform. The Q&A sessions address the problems students faced while working on the activities. Students attempt the smaller activities during class time, and the more extensive DIY activities are completed at home. Students received class participation points for attempting and not necessarily completing these activities. These activities prepare students to complete graded assignment problems and the exams.

4. THE STUDY

This study's primary intent is to analyze students' perceptions of the task value and their self-efficacy in an introductory programming course. This study is conducted in an undergraduate computer programming course that teaches introductory programming using Java. Results of a final, end-of-the-course survey are used to study the student perceptions of the usefulness of various learning activities and students' perceived self-efficacy to learn computer programming. Appendix A shows the final survey questions. An initial survey during the beginning of the course was also used to assess the learning needs of the incoming students. The questions of the initial survey are as listed in Table 3.

The surveys used a 5-point Likert scale to score student responses. Nineteen students attempted the final survey, and 20 students attempted the initial survey. Student surveys are administered anonymously during class time. Students were required to attempt all the assigned skill-building/learning activities assigned throughout the course. Practicing these skill-builder activities could potentially give enough cognitive and learning skills to help students regulate their efforts towards writing good computer programs.

5. RESULTS

5.1 The need for instruction of skills to learn to program

Table 3 shows the results of an initial survey conducted during the first week of the course. Students were less concerned about how much they could master this course's contents than about having the right skills and abilities to learn to program. This survey was administered to students during the first week of the course after the instructor discussed the course syllabus.

Table 3 indicates the self-reported prior experience with computer programming. Since data collected using a 5-point Likert scale is ordinal, a Spearman-rank correlation method is used to investigate the correlation between the degree of prior exposure to computer programming and students' learning concerns. Prior exposure to programming negatively correlates with a moderately significant correlation coefficient (rho of -0.6, $p = 0.005$)

with the students' concerns about having the right skills to learn to program.

	Very Much Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Very Much Agree
I am concerned about how much I can master the subject matter	2	3	2	7	6
I am concerned if I have the right skills to learn programming	1	6	6	3	4
I have some prior knowledge of programming	8	3	2	3	4

Table 3. Survey response distributions on the perceived self-efficacy to learn to program - before attending the course.

The correlation between prior exposure to programming and concerns about learning the subject matter was not significant (rho = -0.3, p=0.15). These results show that students with lesser prior exposure to programming were more concerned about having the right skills to learn to program than their concern about mastering the subject matter. These results pointed to the possibility that an instructional strategy that included explicit activities to build essential learning skills might be valuable to develop students' perceived self-efficacy in their ability to learn to program.

5.2 Perceptions of the value of learning activities in the course

A final survey administered at the end of the course showed the perceived value of various learning activities that became a regular part of instruction throughout the semester. Appendix A lists the final survey questions. Table 4 shows some of the results of the final survey. Most students agreed that practicing and participating in these learning activities were valuable in acquiring the programming skills that they were expected to learn from the course.

All the activities, except for the Q&A sessions, required students to apply their knowledge and skills to identify the problem, plan the solution, write the code, correct errors, and test the code –all by themselves. These activities provided students with different ways to apply one or more SRL skills related to learning how to develop programming solutions. The Q&A sessions were the time when students obtained help and feedback from the instructor.

	Very Much Disagree	Disagree	Neutral	Agree	Very Much Agree
Q&A sessions	0	0	1	11	7
Messed Up Code	0	0	1	12	6
Hack the Code	0	0	1	11	7
Test Tube	0	0	1	7	11
DIY	0	0	4	13	2

Table 4. Student response distribution on the effectiveness of different learning activities in developing programming skills

Survey results on students' perceptions, depicted in Table 5, showed that 18 out of 19 respondents agree or strongly agree that they feel comfortable experimenting with their code.

	Very Much Disagree	Disagree	Neutral	Agree	Very Much Agree
I feel that learning how to program has improved my problem solving skills	0	0	3	7	9
I feel confident to experiment with my programs	0	0	1	8	10
I feel confident that I can correct programming errors	0	0	0	9	10
I believe that one can master programming only by working on independently on hands-on activities	1	2	6	7	3

Table 5. Student response distribution on various indicators of student self-efficacy related to learning programming

All the respondents also report that they feel confident in their ability to correct programming errors. Out of the 19 respondents, 16 (85% of respondents) feel that learning how to program has improved their problem-solving skills. However, nearly 9 out of 19 (48%) respondents do not believe that they can master programming only by working independently on hands-on activities. At the same time, high value of the Q&A sessions, as shown in Table 4, shows that students have relied on getting help from the instructor through the Q&A sessions.

5.3 Correlation studies

A Spearman-Rho correlation was used to study the co-occurrence of various factors indicating self-efficacy (listed in Table 5) and the perceived value of various instructional methods (listed in Table 4). Table 6 shows the value of rho and p values after correlating the student responses. For the sample of 19 respondents, there existed a significant correlation (rho = 0.6, p < 0.01) between students' belief in their ability to independently master programming and the perceived value of doing many DIY activities.

	Task Value of Q&A	Task Value of DIY	Task Value of Messed-up-code	Task Value of Hack-the-code	Task Value of Test-Tube
Improved problem solving skills	**(0.57, 0.01)**	*(0.308, 0.13)*	*(0.07, .8)*	*(0.21, 0.38)*	*(0.21, 0.38)*
Experiment with programs	*(0.4, 0.08)*	*(0.25, 0.56)*	*(-0.06, 0.65)*	*(0.03, 0.9)*	*(0.05, .8)*
Correct programming errors	*(0.33, 0.16)*	*(0.18, 0.44)*	*(-0.16, 0.68)*	*(0.5, 0.5)*	*(0.5, 0.5)*
Master programming only by doing indepedent hands-on activities	*(0.4, 0.08)*	**(0.6, 0.006)**	*(0.46, 0.04)*	*(0.3, 0.20)*	*(0.19, .40)*

Table 6. Correlation results showing values of rho and p

Another significant correlation (rho = 0.6, p< 0.01) existed between the value of the Q&A sessions and the perception that learning to program has improved their problem-solving skills. No significant correlation was found to ascertain that the perceived values of Test-tube or Hack-the-code are associated with any of the factors that indicate the perceived self-efficacy measure listed in Table 5. A moderately strong correlation was seen between the value of messed-up code and the perceived ability to master programming independently.

5.4 The Instructor's reflection on the results

Both the Q&A session and the DIY activities involved the instructor's support to a much greater extent than the Test-tube, Hack-the-code, or the Messed-up-code activities. The DIY activities problems were very similar to those used in the code-demos to explain problem-solving. The code-demos provide a scaffold for students to work on their DIY problems. However, the DIY activities did require students to read the question prompt, discover a similar problem in the code-demos, write the solution, implement the code, debug, and test the codes with various inputs. The DIY activities resembled mini-projects, while the other learning activities were shorter problem-solving activities. Students were provided with a pre-written code for the Messed-up-code, Test-tube, and Hack-the-code activities. The value of completing the DIY programs by 'walking in the instructor's shoes' seems to correlate more with the belief that students can master programming through independent practice.

By reflecting upon the classroom experience, it was observed that students did not require much help from the instructor to complete the DIY activities. This could be due to the fact that the DIY closely resembled the examples in the code-demos that had extensive documentation corresponding to the planning, reflection and implementation phases of SRL. However, to complete the Test-tube, Hack-the-code, and Messed-up-code activities, students had no template to work with and had to recall similar problems or situations from their memory. As a result students required more help from the instructor for these activities. Majority of the Q&A sessions addressed ways to reformulate the task and identify similar problems from experience.

From an instructor's perspective, asking questions and seeking help is an important skill required to become independent, self-directed learners. A student who considers Test-tube and Hack-the-code as valuable to their learning is still not likely to say that they believe they can master programming independently, possibly because they needed more help and support to complete the tasks. Compared to the Test-tube and Hack-the-code activities, the Messed-up-code, which moderately correlated with belief in independent-mastery, did not require students to alter the inputs. A significant correlation between confidence in problem-solving skills and the value of Q&A indicates that students are likely to view help and support as factors that improve their problem-solving, but not necessarily towards developing independent-mastery.

In addition to needing more help with the Test-tube, Messed-up-code, and Hack-the-code, students tended to make more mistakes, even though they would eventually figure out a way to correct the mistakes. From an instructor's perspective, learning how to correct mistakes indicates self-regulated learning. However, if students perceive mistakes negatively, they are less likely to register these activities as contributing to their confidence to learn independently. Despite their perceived task value, Test-tube, Messed-up-code, and Hack-the-code, they were not significantly correlated to confidence for independent mastery.

6. CONCLUSIONS

This study investigates the student perceptions of the role of teacher-practice activities and teacher-modeling activities in an introductory computer programming class. The majority of the students agree that all the hands-on learning activities had significantly helped them acquire the programming skills, even though more than half of the students reported that they were not confident in their ability to master programming independently. Emulating the instructor's coding process through the DIY activities is what the students found as most valuable in mastering their programming skills independently, and the Q&A sessions were strongly perceived and correlated with confidence in problem-solving skills. Future iterations of the course could consider tweaking the self-directed learning activities so that students can see the value of making mistakes and getting help as an essential part of their ability to master programming independently. Future studies could look into learning strategies that could help students regulate their behavior and motivation at a granular level as they encounter learning challenges.

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Appendix A

Final Survey - conducted at the end of the course					
Please answer these questions based on your learning experience in the CIS 120 course	**Very Much Disagree- 0**	**Disagree- 1**	**Neutral- 2**	**Agree - 3**	**Very Much Agree-4**
The Q&A session is a valuable learning method for this course					
Test-Tube: Experiementing with code is a valuable learning method for this course					
DIY : Trying out the code-demos using Eclipse is a valuable learning method for this course					
Messed-up-code: Analyzing and fixing an errored code is a vauable learning method for this course					
Hack-the-code: Experimenting with the code to alter the outputs helped me learn better					
I believe that one can master programming by working only independently on hands on activities.					
I feel that learning how to program has improved my problem solving skills					
I feel confident to experiment with my programs					
I feel confident that I can correct programming errors					

Appendix B

1. **A Sample DIY problem:**

Shopping Cart – Create a file called ShoppingCart.java

Please refer to the code demo called **VariableDataEntry.java** prior to attempting this problem. This problem shows you how to:

- obtain data from the user, scan this data, and save it in an appropriate variable.
- perform arithmetic using the numeric data types,
- print a message displaying values of all the variables.

In this program you will capture data of an item for a ShoppingCart application. Your program may need to know the following properties: customer_name, item_name, item price, sales tax rate, item quantity, calculated total price of all items in the cart

A ShoppingCart may need the following behaviors:

- Obtain the following data from the user for a single item: customer_name, item_price, sales_tax_rate, item_quantity. Scan these values and store them in variables of appropriate data type.
- Calculate the total price of all items in the cart
- Print a message listing all the item variables with its total calculated price (that includes the sales_tax factored in).

2. **A Sample Hack-the-Code activity**:

Refer to the code called AgeCheckerCase2.java.

```
import java.util.Scanner;
public class AgeCheckerCase2 {
    public static void main(String[] args){

        //Declare the input variable
        int age = 0;

        //Declare output variable
        double ticketPrice = 0.0;

        //Declare other variables
        double salesTax = 0.05;

        //Decision structure
        if(age < 12) {
            salesTax = 0.2;
        }

        ticketPrice = ticketPrice*(1+salesTax);

    }
}
```

Hack this code so that your decision structure calculates the ticketPrice based on the following rule: For an age that is less than 12, give a 20% discount on ticketPrice, but for an age greater than 65, give just 10% discount on the ticketPrice for all other age groups between and including 12 and 65, give just 2% discount on ticketPrice.

3. A Sample Test-Tube activity

```java
public class TracingWhileLopps_3 {
    public static void main(String[] args){

        int i = 0;
        int result = 0;
        int gate = 5;
        int n = 1;

        while(i<gate){

            if(i/4 == 0){
                result = result + 1;
            }
         i = i + n;
        }
    }
}
```

1. Determine the value of result, i/4 and (i<gate) for each iteration of the while loop and complete the table shown below

gate = 5	n =2	i	result	i/4	i<gate
5	2	0	0		
5	2				
5	2				
5	2				
5	2				
5	2				

2. Determine the value of result, i/4 and (i<gate) for each iteration of the while loop and complete the table shown below for a gate = 10 and n = 3. Add more rows if needed.

gate = 10	n =3	i	result	i/4	i<gate
5	2	2	0		
5	2				
5	2				
5	2				
5	2				
5	2				

A Sample Messed-up Code Activity

Problem: Use decision structures to check if a variable **userLetter** is a vowel in the English alphabet. Assume the value of userLetter is already obtained from the user and set to an appropriate data type in each of the following responses. Correct the errors each of the following responses that assumes a given data type for userLetter,

Response 1: userLetter is a String.

```
if (userLetter.equalsIgnoreCase "a"){

System.out.println("Letter is a vowel");

}


if (userLetter.equalsIgnoreCase "e"){

System.out.println("Letter is a vowel");

}


if (userLetter.equalsIgnoreCase "i"){

System.out.println("Letter is a vowel");

}


if (userLetter.equalsIgnoreCase "o"){

System.out.println("Letter is a vowel");

}


if (userLetter.equalsIgnoreCase "u"){

System.out.println("Letter is a vowel");

}


else{

System.out.println("Letter is not a vowel");

}
```

Response 2: userLetter is a char

```
if(user == a){

            System.out.println("It’s a Vowel ");

        }
```

```
else if (user == e){
            System.out.println("It’s a Vowel ");
        }
else if (user == i){
            System.out.println("It’s a Vowel ");
        }
else if (user == o){
            System.out.println("It’s a Vowel ");
        }
else if (user == u){
            System.out.println("It’s a Vowel ");
        }
else {
           System.out.println("Not a vowel ");
        }
```

Response 3: userLetter is a String and you need to use a || in your if condition

```
if else(letter.equalsIgnoreCase("A||E||I||O||U")){
        System.out.println("you got a vowel");
}
```

Response 4: userLetter is a char and you need to use a || in your if condition

```
if (userLetter = a || e || I || o || u) {
System.out.println("This letter is a vowel.");
else if () {
System.out.println("This letter is not a vowel.");}
```

Aligning the Technical and Soft Skills of Management Information Systems and Business Analytics Curricula to Supplement Accounting Education

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Abstract

Familiarity with management information systems (MIS) and business analytics (BA) knowledge and soft skills facilitating teamwork are becoming critical for business-related disciplines. This study explores the need for information systems (IS) and analytics courses and soft skills in accounting positions by analyzing accounting job listings in a geographic job market as well as those from national accounting firms. Using content analysis, we found a critical need for IS and analytical knowledge. Nearly half of all entry-level positions indicated applicants were expected to have knowledge of concepts taught in a systems analysis and design course (SA&D). Additionally, 89% listed analytics skills, while 19% required database knowledge. These findings suggest IS and analytics expand the marketability of accounting students. Further, this research revealed a wide range of soft skills that entry-level accountants were expected to demonstrate, including presentation skills and teamwork, which would be improved through classes consisting of students from diverse majors. The findings indicate the need for IS programs to offer transdisciplinary IS and analytics courses that can provide business students with opportunities to develop practical skills, an asset in a team-driven workplace.

Keywords: Curricula, Information Systems, Business Analytics, Accounting

1. INTRODUCTION

A best practice for management information systems (MIS) programs to encourage enrollment is to add data analytics programs and cross-sell courses to other departments (Koch, Slyke, Watson, Wells, & Wilson, 2010). Expanding on this idea, we evaluate how MIS courses can meet the accounting professional's educational needs. Due to the advancement of new areas in information technology (IT) and data analytics, the need for analytical skills has risen, and expectations for business school graduates increasingly include the ability to, within a team structure, analyze systems and provide suggestions for improvements. Thus, information systems (IS) departments should provide additional opportunities to develop advanced IS and analytical skills for accounting students.

MIS capture, store, process, and communicate data, information, and knowledge. Similarly, Guragai, Hunt, Neri, and Taylor (2017) observed that organizations use accounting information systems (AIS) to help control and allocate their resources to enable and limit those who engage in transactions. According to Jafar, Babb, and Abdullat (2017), the field of data analytics has tremendous potential to improve an organization's use of IS.

The IS field is facing many challenges driven by an increase in globalization, cloud computing, the integration of enterprise resource planning (ERP), ubiquitous mobile computing, and the modernization of IT frameworks (Topi, Valacich., Wright, Kaiser, Nunamaker, Sipior, & Vreede, 2010). Despite the importance and the demand for MIS professionals, enrollment has declined. To redesign their curricula, some programs look to match their MIS curriculum to the hiring requirements of MIS graduates (Burns, Gao, Sherman, & Klein, 2018). But, given that MIS supports the entire organization, MIS departments should also explore the learning needs of other business students, complementing the course offerings of other departments, such as accounting.

The American Institute of Certified Public Accountants (AICPA), and other leading professional accounting societies, recommend the alignment of accounting and IS. Some universities have added AIS or IS related concentrations, tracks, certifications, or majors, offering students an opportunity to blend the most critical accounting concepts with essential IS concepts (AIS; Dillon, & Kruck, 2008; Chayeb and Best, 2005). The demand for such programs is supported by the AICPA offering certifications in IS and data analytics. If the demands of the accounting profession and other departments require more IS and analytical knowledge, universities should respond. Currently, some programs may only offer an AIS course (Neely, Forsgren, Premuroso, Vician, & White, 2015). MIS bridges technology to other functional areas, a task complicated by rising dependence on connectivity and algorithms. For MIS departments to survive, they must not only provide technically astute MIS students but also raise the importance of understanding of MIS to other business disciplines. By also serving other departments, they will be able to create diverse teams that will aid in developing soft skills among all graduates.

Universities and students, however, have limited resources that restrict the number of courses offered or that a student may take. It is, therefore, necessary to identify key concepts that relate. To address this need, this study aimed at examining accounting employer demand for specific aspects of the MIS curriculum, specifically database, enterprise systems, and SA&D (Topi et al., 2010). We content-analyzed job listings to determine whether accountants need these core subjects. Additionally, we examine the listings to determine the demand for analytics. Finally, as education professionals, we wanted to determine the essential soft skills that we need to develop in students as we teach core MIS concepts. Our general research question is: Do recent accounting job listings contain knowledge, skills, and abilities covered by existing MIS and Business Analytics (BA) courses? The following specific research questions guided the analysis:

1. What MIS courses best benefit the career needs of accountants?
2. What BA courses best benefit the career needs of accountants?
3. What soft skills should be emphasized in MIS and BA coursework to benefit accountants?

2. LITERATURE REVIEW

The section will first review literature on existing AIS, then MIS curriculum guidelines, and key MIS and BA subject areas, and finally, soft skills.

Accounting Information Systems (AIS)

We have adopted Romney and Steinbart's (2018) definition of AIS: systems that identify, collect, store, manage, and communicate accounting data and information for reporting and control. In AIS, reporting generates information comprised of both financial (e.g., statement of cash flows, income statement) and nonfinancial information (e.g., employee addresses). AIS emphasizes the use of systems to control and allocate resources, helping to enable and limit those who engage in certain transactions, making accountants play the role of gatekeeper and requiring them to know the system (Guragai et al., 2017). Despite the evidence of the importance of AIS and changes in technology, most accounting programs may only offer a single AIS course or may not have the requirement at all (Larkin, 2020, Kearns, 2014). Further AIS courses have not substantially changed their content over the past decade (Larkin, 2020), suggesting an opportunity for MIS programs to provide courses as valuable electives for accounting students and gain knowledge on emerging information technologies. We examined the current MIS curriculum guidelines to determine the best courses to supplement MIS knowledge for accounting students.

MIS Curriculum Guidelines
The most recent MIS guidelines by the Association of IS were published in 2010 and they have been used to both evaluate course requirements by MIS departments (Bohler et al., 2020, and to evaluate skill requirements (Burns et al., 2018). Topi, et al. (2010) suggest core MIS courses include Foundations of IS, Data and Information Architecture (Database), Systems Analysis and Design (SA&D), IS Project Management, IT Infrastructure, Enterprise Architecture (ERP systems), and IS Strategic Management. MIS professionals use IS to achieve organizational goals, and MIS faculty strive to create programs providing a balance of education and experience (Computing Curricula 2005; The Overview Report, 2006). Meanwhile, an AIS's effectiveness relies on the design of the system controls and the organization's training, implying that knowledge of how data are stored, and the design of the controls related to the system are essential to AIS (Shagari, 2017).

The AICPA (2019) notes that organizations are becoming more data-driven. The AICPA provides credentials to bridge the gap between IS and accounting, such as the Certified IT Professional (CITP). The CITP allows certified public accountants (CPAs) a path to opportunities bridging business and technology. The CITP provides additional certification in IT assurance, risk, security and privacy, analytics, and technology. The AICPA also sees data analysis skills as increasingly necessary, making the data analyst critical to an organization. Data analysts help leaders make informed, data-driven decisions to drive the company forward, improve efficiency, increase profits, and achieve organizational goals. To meet industry demand, the AICPA (2019) developed the Data Analyst Certificate, a comprehensive five-part certificate program providing training and practical guidance on data analytics. The preceding observations led us to focus this research on database, Enterprise Architecture, and SA&D as the MIS topics. IS Security was considered but is not a widely required course (Bohler et al., 2020) and may overlap with listed courses. The primary tenets of these MIS subject areas are reviewed in the following three sections.

Data and Information Architecture (DIA) For this research, we adopted Stephens' (2008) definition of databases as tools that store data and let you create, read, update, and delete data. A DIA course covers database topics including database approach, types of database management systems, basic file processing concepts, conceptual and logical data models, database languages, data security and quality management, and business intelligence (BI) (Topi et al., 2010). Research suggests a gap exists between current database offerings and employers' needs (Yu & Chary, 2013).

Enterprise Architecture (EA)
An extension of DIA, EA can be described as the merging of several databases to serve the organization. ERP systems are software suites built to collect and organize data from various levels of an organization. They help businesses run critical processes, such as manufacturing, supply chain, sales, finance, human resources, and others (Almajail, Masa'deh, & Tarhini, 2016), and are among the best information technologies available to organizations to synergize internal resources and support critical business functions. ERPs have become integrated, with core infrastructure applications based on large-scale enterprise systems, moving the focus from system development to configuration and implementation. ERP includes topics like supply chain management and customer relationship management (Topi et al., 2010). Since ERP embrace every business aspect, an unsuccessful ERP launch may cripple an organization's ability to serve customers and cause financial difficulties (Saade & Nijher, 2016; Frejiik & Powell, 2015). According to Mekadmi and Louati (2019), the implementation of ERPs has blurred the lines of responsibilities for accounting and IS. Employers recognize the need for properly designed IS and input from all stakeholders (Dillon and Kruck, 2008). The importance of ERPs requires that accountants understand ERP, database concepts (Wilder et al., 2004).

Systems Analysis and Design (SA&D)
According to Harris, Lang, Oates, and Siau (2006), SA&D is an approach to the development of IS encompassing the first four phases of the systems development life cycle (SDLC)–Planning, Analysis, Design, and Implementation–connecting business problems to the design of IS solutions. SA&D education helps developers avoid designing IS that are ineffective, inefficient, or resulting in user dissatisfaction. Possible causes for poor system performance include misalignment of controls, the control environment, mechanisms, execution of control,

and socio-emotional behaviors (Cram, Brohman, Chan, & Gallupe, 2016). Poor system performance strains the IT department's relationship with other departments as they move to achieve different organizational initiatives such as BI (Etnyre, & Lehmann, 2015). The role of IS professionals in terms of control design is to design and implement IT solutions that enhance organizational performance. In contrast, for accountants, their role in control design is to add value in the process by providing financial expertise, participating as team players, and taking decision-making roles while integrating operational and strategic controls (Mahony & Doran, 2008). According to the Association for Information Systems 2010, students should "possess skills in modeling processes and data, defining and implementing technical and process solutions, managing projects, and integrating systems" (Topi et al., 2010, p. 8). Furthermore, modern SA&D is increasingly using agile methodologies such as Scrum, where IT is directly working with end users and forming teams that complete projects using multiple iterations.

Business Analytics (BA)

BA is the process of providing meaningful insights from data. BA is in demand in the IS industry, but also in accounting (CGMA, 2016). The rise of big data has created increasing needs for new data and models. According to Bichler and Heinzl (2016), BA includes BI, data exploration, data transformation, data preparation, storage and retrieval, predictions (forecasting), presentation of explanations, and related topics. While an organization may have dedicated personnel working on corporate data analysis projects, they may not have the capacity to work on department level information projects. The Standard Occupational Classification System (United States, 2017), the Bureau of Labor Statistics (BoLS) states that Data Scientists:

> Develop and implement a set of techniques or analytics applications to transform raw data into meaningful information using data-oriented programming languages and visualization software. Apply data mining, data modeling, natural language processing, and machine learning to extract and analyze information from large structured and unstructured datasets. Visualize, interpret, and report data findings. May create dynamic data reports. (p. 22)

The SOCS goes on to provide example occupations to include BI Developer, Data Analytics Specialist, Data Mining Analyst, and Data Visualization Developer. One of the suppositions of this article is that accountants and auditors, defined by the SOCS as someone who examines, analyzes, and interprets accounting records to prepare financial statements, gives advice, or audits and evaluates statements prepared by others (United States, 2017, p. 14), are now doing some of the work usually associated with data analysts in their daily jobs. Thus, the need for analysis, and analytical modeling, and decision support skills have prompted many MIS programs to include analytics courses in their curricula.

Financial applications in the accounting industry do an excellent job of processing data into information for accountants. However, these programs may not provide methods to conduct ad hoc analysis and reporting. As a result, CPAs must become adept in using Microsoft Excel and other analytical software as technology evolves to handle today's changing needs for information (Blackwood, 2014). Accounting departments have identified this need and are beginning to integrate data analytics into introductory accounting courses using Excel, Power BI, and Tableau (Tietz, Miller-Nobles, & Cainas, 2019). However, initial exposure to analytics using these tools may be insufficient as new systems apply various statistical models and artificial intelligence algorithms to large datasets to continuously detect potential issues (Flynn & Stevenson, 2018). Big data analytics have resulted in substantial competitive gains across all industries (Mikalef, Pappas, Krogstie, & Giannakos, 2018).

Soft Skills

"It is people, not technology, who make sense of data and give it meaning. This means that business intelligence resides not in the data warehouse but in the minds of people" (CGMA, 2016, p. 3). A report from the Chartered Global Management Accountants (CGMA) points out that competence in technology is not enough to add value; a professional also needs to possess excellent decision-making skills and other soft skills. Schools also need to align their pedagogy to match required soft skills (Beard et al., 2008). The softs skill requirements widely vary in terminology and focus; however, in prior research connecting accounting and MIS planning, communication, leadership, and team building, have been a focus (Beard et al., 2008). Accounting curriculums specifically have focused on communication, problem solving, leadership and teamwork, ethical and moral values, and self-management (Villiers, 2010). Softs skills were also evaluated by using word counts from job descriptions identifying problem solving, teamwork, analytical skills, time management, and self-motivation as the most common soft skills needed for MIS (Burns et al., 2018).

Timeliness
Organizations often need to have tasks performed within a strict schedule. The accounting profession mandates regular reports. However, this practice is not consistent with modern pedagogy that would have instructors provide more flexible deadlines with millennial students (Wilson & Gerber, 2008). While flexible deadlines are now expected in education, poor performance is penalized in the workplace (Rashly, Pit, & Ting, 2016).

Presentation
Villiers (2010) lists presentation skills as negotiation skills, active listening skills, questioning techniques, persuasion, conflict resolution, understanding different perceptions, handling objections, giving and receiving feedback, rapport building, written communication, and report writing, implying that accountants need effective oral and written communication skills. Accountants work closely with colleagues in various organizational roles, and invariably, their job performance is partially dependent on their ability to communicate (Kavanagh & Drennan, 2008). Capabilities should include listening, observing, interviewing, and analyzing archival materials, writing memos, reports, and documentation, using virtual collaboration tools, and giving effective presentations (Topi et al., 2010). Pedagogy has adapted to address this need as flipped classrooms have been used in accounting and to strengthen soft skills such as communicating ideas through student-led presentations and teamwork (Cord, 2018; Lubbe, 2016).

Teamwork
As with presentation skills, accountants must exhibit strong team skills (Kavanagh & Drennan, 2008). Professionals should collaborate effectively with other professionals as well as perform successfully at the individual level (Topi et al., 2010). A core concept of flipped classroom pedagogy has been to allow students to self-learn within groups so that they may learn from each other and develop required soft skills (Cord, 2018).

Accountability
Accounting program graduates will be required to act in various collaborative roles during their professional careers, and most of them will likely be assuming leadership positions at various levels (Kavanagh & Drennan, 2008), often in a global context. Programs must prepare their graduates to be active collaborators and inspiring leaders. Capabilities should include leading cross-functional global teams, managing globally distributed projects, and structuring organizations effectively. Utilizing systems development techniques in classes such as SA&D would allow students to act in leadership roles such as Scrum masters within a flipped classroom and would allow them to develop leadership, accounting, and soft skills (Rush & Connolly, 2020; Hall, 2018).

Critical Thinking
This research uses Villers' (2010) definition of critical thinking: creativity, analytical skills, framing issues, asking questions, probing, and awareness of ambiguities and complexities. Strong analytical and critical thinking skills are a foundation for everything that accountants do; they must be able to systematically analyze complex systems and situations, break them down into manageable components, understand deep connections within systems, and create solutions based on the results from a systematic analysis. Problem-solving is also omnipresent in the life of accountants. Capabilities should include analyzing the ethical and legal implications of complex situations, analyzing the risks associated with complex systems, solving complex problems, using quantitative analysis techniques appropriately and effectively, and enhancing innovation and creativity in oneself and others. Teaching how designers think is one way to foster critical thinking (Glen, Suciu, & Baughn, 2014).

3. RESEARCH METHODOLOGY AND DATA COLLECTION

To determine if the previously discussed technical topics and soft skills were evident in recent accounting job listings, this research used a simplified content analysis approach to evaluate the content of texts (White & Marsh, 2006). Content analysis requires an iterative process of unitizing, sampling, recording, and reducing the text until the desired level of quality is attained (Krippendorf, 2004).

For this research, the process consisted of defining the scope of job listings relevant to this study, collecting them for review, and creating an instrument to reduce the listings to meaningful data. After several iterations, the target job listing scope was defined as local (within 100 miles of the university), full-time positions, requiring an accounting degree, and pursuing CPA certification. The initial data collection occurred in July of 2019, with 158 job listings of local accounting firms gathered from Indeed.com, and in August of 2019, an additional 45 job listings were gathered from national accounting firms consisting of the "Big four" (Deloitte, KPMG, PricewaterhouseCoopers, and Ernst & Young). After discarding irrelevant job listings and duplicates, a total of 86 job listings remained.

Job listings were indexed, reviewed, and coded by two of the three researchers and finally arbitrated by the third to deconflict any issues. A small subset of the job listings was first examined to pilot a coding instrument to facilitate the coding process. The instrument was refined after coding the first subset of job listings to ensure inter-coder consistency in understanding the codes, keywords applied, and experience. Table 1 lists the finalized coding instrument, which includes 11 codes.

Six of the codes relate to MIS and BA areas. The code, *Database*, refers to whether the job posting included an expectation of applicants' database knowledge. *Report Writing/Generation* addresses a requirement for making reports of any kind (including reports directly generated by IS and ad-hoc reports written based on information or data generated by IS), including financial statements. While this also implies excellent written communication, a soft skill, this was recorded as a technical skill. *Enterprise Architecture* was coded when the position involved the use of ERP or required experience in using a system classified as such. *SA&D* was applied when the job entailed design, testing, control, and/or analysis of the system. *Data Analytics* addresses whether the job posting mentions any need to analyze data. The jobs were also coded for the use of Excel.

Five codes were applied to classify soft skills mentioned in the posting. They included *Timeliness* for completing work promptly; *Teamwork* for working well with others; *Presentation* for requirements for formal communication, including presenting a report in front of others; *Accountability* leading or handling tasks with no supervision; and *Critical Thinking* for the ability to process and understand complex information.

In addition to the codes, the job postings were also classified for the *experience level required* (Entry, Some, Very) and *firm type* (National or Local). The results are discussed in the next section.

4. RESULTS

The final sample consisted of 44 postings from the national accounting firms and 42 from local firms. Thirty-seven postings were for entry-level positions, while 31 and 18 postings targeted applicants with some and extensive experience, respectively.

Table 2 reports the content analysis results organized in MIS, BA, and soft skills to allow contextual evaluation of the results. Their contingent frequencies by firm type (local, national), and if stated, the years of experience required in the job listing are also reported to delve into relative rates of occurrence of the codes in the job listings.

MIS

IS knowledge and skills in demand in the job postings include report writing/generation (80%), SA&D (38%), enterprise systems (14%), and knowledge in database (13%), in this order of frequencies.

Database knowledge was the least frequently mentioned MIS knowledge area. However, systems analysis and enterprise systems require knowledge of database concepts. Report writing or generation is another area that may be aided by general database knowledge. Ad hoc analytical reports are often based upon queries written on a database, and knowledge of database management systems (DBMS) would aid in independently generating these reports. Knowledge of database was more commonly required in entry-level positions.

Knowledge related directly to enterprise systems was required by nearly 14% of all job listings but was less frequently in entry-level positions (11%). Interestingly, enterprise systems knowledge requirements were more prevalent in local firms, with nearly 24% listing a specific or generic enterprise system knowledge as a requirement, than in large national firms (5%). Perhaps local or managerial accountants are more frequently required to participate in the operation of a specific system while national firms are auditing or consulting for multiple organizations.

SA&D was the most common MIS subject required, as 38% of the job listings discussed the need to evaluate and improve existing systems. The national firms required job seekers to analyze, and design solutions/improvements in controls or processes in more than 50% of all their job listings. Furthermore, nearly 49% of all entry-level positions were required to have skills related to SA&D, suggesting that as accounting students enter the workforce, they need to have the tools to analyze their organizations' IS and suggest improvements. While knowledge of database was listed, other technical aspects of SA&D, such as programming or networking skills, were not frequently required, indicating that the courses designed to teach SA&D should heavily emphasize the design of the controls, modeling processes, and testing.

In this sample, most (80%) of the positions listed report writing or generation as part of the job's requirements. Of note, report writing was listed in nearly 84% of all entry-level positions, indicating that students should have that skill as they enter the workforce.

The findings are consistent with previous research indicating that MIS skills are needed and that students would better align with employer demand with additional training in skills such as database (Kavanagh & Drennan, 2008). The findings are also supported by the AICPA, which offers additional certifications related to IS.

Business Analytics

Accounting requires analytical skills, with over 87% of the job listings requiring general data analytics skills (Table 2). National firms (83%) and entry-level positions (89%) exhibited a strong demand for general analytical ability, with the need for forecasting as the most specific analytic skill mentioned. Excel was mentioned by only one out of four positions, which is surprising given that components of the CPA exam are conducted in Excel.

While specific skills were not mentioned, certifications offered by the AICPA in analytics suggest that these skills are quickly going beyond the analysis traditionally performed in the accounting function. Our literature review also suggested the need for analytical skills, including Excel (Kavanagh and Drennan, 2008).

Soft Skills

Technical skills are in demand, but according to this sample, they need to be accompanied by soft skills, given that each soft skill coded appeared in a majority of the job listings (Table 2). The ability to meet deadlines, work in teams, present results, be accountable, and critical thinking are all essential.

While the creation of PowerPoints and written communication are teachable skills, other soft skills are challenging to impart in dedicated classwork. Our findings reveal that it is essential to offer students opportunities to practice these soft skills. Modern organizations expect graduates to have the ability to teach or explain to others the specifics of processes and present them to various stakeholders while working in a team framework. These results underline the importance of group work in the classroom to provide students an opportunity to practice leading and managing cross-functional teams and complete tasks within a specific schedule. Providing real-world project management experience would be ideal as it would allow students to interact in diverse groups while forcing them to use technical knowledge and critical thinking.

Based on these findings, Table 3 summarizes the answers to the specific questions posed by this research. The findings suggest that recent accounting job listings do include skills that are taught in MIS or BA courses. While there was weak evidence for MIS overall, entry-level job listings had a higher percentage, indicating that this requirement is newer to the profession.

5. LIMITATIONS

About half of the sample were job postings from national accounting firms, and the other half were postings from local firms in a single region in the United States. Therefore, the ability to generalize is limited. The sample also represents a snapshot of time, and the local firm postings were selected through only one job search site. Ideally, the researchers would have liked to include additional listings gathered from a variety of sources such as college recruiters.

6. CONCLUSIONS

We found that IS knowledge, analytics ability, and soft skills are widely required even for entry-level accounting positions, suggesting that it is essential to expand the opportunities for accounting students to gain knowledge and experience in these areas. The technical skills required by accountants are being reflected in the increased certification offerings by the AICPA. Accountants in entry-level positions are increasingly being asked to have more technical knowledge to contribute immediately to the improvement of controls and the efficiency of an organization. These results provide a call for IS and data analytics programs to offer certifications and minors or serve as required components to an accounting degree program.

MIS departments should work to provide opportunities for accounting students to enroll in database and SA&D courses to learn skills that will help with ad hoc reporting and the skills necessary to analyze and design efficient systems with adequate controls. Courses with accounting, MIS, and data analytics students would allow for more diverse teams and perspectives while completing projects and presentations. This would also provide administrative benefits as increased enrollment allows options for class sizes and section numbers that may reduce preparation work for faculty.

Analytics departments should work to provide opportunities for accounting students to join their courses. Forecasting was the most widely required skill listed in our sample, indicating that regression and time series would be relevant models for instruction. However, additional research is needed to explore other MIS and BA concepts and skills that would be important for accountants. Courses such as data mining or BI would allow a variety of models to be explored. Such a course would connect well with skills learned in a database course to provide a wide range of skills to produce ad hoc reports. Excel skills are a must for accounting students. Business schools should continue to offer a venue to practice Excel skills while also expanding the student’s horizons on the use of other software.

Educators need to continue to emphasize soft skills in their classrooms. While the technical knowledge may be required so are soft skills. A lack of IS knowledge may exclude the jobseeker from many positions, but the knowledge needs to be taught in a manner that allows the student to practice soft skills and interact in a diverse team environment.

The findings provide a framework to evaluate job listings for relevant content related to analytics and IS so that other departments or areas within the college of business can evaluate the need to increase their student's exposure to MIS and BA. Further research is needed to ensure that course offerings are aligned with employers of all graduates. As MIS graduates need to communicate findings across departments, incorporating students from other departments into MIS classrooms or projects may facilitate soft skills and create healthier programs.

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Appendix A: Tables

Code	Instrument Keywords
Management Information Systems	
Database	SQL, Database, Specific Databases (e.g., Access, Oracle, MYSQL), Data Integration, Data Collection, Storage
Report Writing / Generation	Report Writing, Financial Statement Generation, Ad Hoc Reporting, Generate Reports, Compile Reports
Enterprise Architecture	ERP, MRP, Specific ERP Software Mentioned
System Analysis and Design	Systems Analysis, Systems Testing, System and Process Design Improvement, Design Controls
Business Analytics	
Data Analytics	Analytical, Statistics, Forecast, Forecasting, Data Analysis, Ad Hoc Reporting, Data Mining
Excel	MS Office Suite, Spreadsheet, Excel
Soft Skills	
Timeliness	Timely, Efficient, Timeliness, Deadlines
Presentation	Microsoft PowerPoint, Giving and Receiving Feedback, Teaching
Teamwork	Teamwork, Working with Others, Team Environment, Collaboration
Critical Thinking	Creativity, Analytical Skills, Framing Issues, Asking Questions, Probing, Awareness of Ambiguities and Complexities
Accountability	Leadership, Managing, Structuring, Coordinating, Minor to No Supervision

Table 1. Coding Instrument

Code	Total	Firm Type		Experience Level Required		
		National Firms	Local Firms	Entry Level	Some Experience	Very Experienced
MIS						
Database	13%	11%	14%	19%	6%	11%
Report Writing/ Generation	80%	73%	88%	84%	81%	72%
Enterprise System	14%	5%	24%	11%	16%	17%
Systems Analysis & Design	39%	52%	24%	49%	29%	33%
BA						
Data Analytics	87%	91%	83%	89%	87%	83%
Excel	27%	18%	36%	19%	39%	22%
Soft Skills						
Timeliness	62%	61%	62%	65%	61%	56%
Teamwork	76%	82%	69%	76%	77%	72%
Presentation	59%	77%	40%	59%	58%	61%
Accountability	66%	82%	50%	65%	65%	72%
Critical Thinking	77%	80%	74%	78%	81%	67%
N	86	44	42	37	31	18

Table 2. Occurrences of MIS/BA/Soft Skills Codes in the Sampled Job Listings

Research Question	***Answers***
Do recent accounting job listings identify, at a significant level of occurrence, knowledge, skills, and abilities covered by existing Management of Information Systems (MIS) and Business Analytics (BA) courses?	Yes
What MIS courses best benefit the career needs of accountants?	Database Enterprise Systems Systems Analysis & Design
What BA courses best benefit the career needs of accountants?	Data Mining Business Intelligence Excel
What soft skills should be emphasized in MIS and BA coursework to benefit accountants?	Meeting Timeliness Teamwork Skills Ability to Present Accountability Critical Thinking

Table 3. Research Questions and Answers

IoT Education using Learning Kits of IoT Devices

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Abstract

The rapid growth of inexpensive and easily accessible communicating devices embedded into new or existing physical devices transform them into the intelligent devices that comprise the Internet of Things (IoT). The increasing use of these devices has attracted attention from various sectors, including consumer market, business, industry, health, government, education, research, and many others. In educational sectors, many institutions are exploring the advanced digital infrastructure applications to improve the learning and teaching abilities of the difficult subjects of Science, Technology, Engineering, and Mathematics (STEM). IoT devices in the classroom or in laboratory activities can enhance the learning process with innovative ideas to increase student motivation in much faster and effective ways. In addition to using IoT to enhance the educational process, IoT serves as an important topic of study. IoT education consists of diverse components including hardware, software, programming, and electronics. How IoT is incorporated into the curriculum is based on the programmatic objectives. For non-engineers, non-coders, and many others, IoT courses need to be designed and delivered in a different way than would be done with engineering, engineering technology, and computer science majors. This paper will discuss the use of widely available educational IoT kits that could be used for beginners or non-majors.

Keywords: Internet of Things, IoT, Learning Kit, IoT Education, IoT Application, IoT Development Kit, IoT Starter Kit.

1. INTRODUCTION

The Internet of Things (IoT) is a global platform of interconnected devices converted from dumb and immovable physical devices into intelligent devices that can respond and act to the environment, humans, and other devices in a real-time environment. However, IoT has been defined and interpreted in various ways by different authors and researchers that is appropriate for their application after the term IoT came into existence. This term was first used by Kevin Ashton during his presentation about radio frequency identification (RFID) at Procter & Gamble (P&G) in 1999 (Ashton, 2009). According to Oriwoh and Conrad (2015), IoT represents 'anything at all, depending on requirements.' Cisco (Noronha, Moriarty, O'Connell, & Villa, 2014) termed this as the Internet of Everything (IoE). Cisco states that "IoE brings together people, process, data, and things to make networked connections more relevant and valuable than ever before—turning information into actions that create new capabilities, richer experiences, and unprecedented economic opportunities for businesses, individuals, and countries" (Barakat, 2016). According to Rose, Eldrige, and Chapin (2015), IoT generally refers to scenarios where network connectivity and computing capability extends to objects, sensors, and everyday items not normally considered computers, allowing these devices to generate, exchange and consume data with minimal human intervention.

The present growth of IoT as an emerging technology has attracted many sectors from education, government, health, industry, and many others. International Data Corporation, IDC (2019) estimated that 41.6 billion connected things will be in use worldwide by the end of 2025. Gartner, Inc. (2014) also mentions that a typical family home could contain more than 500 smart devices by 2022. With such immense potential uses of IoT devices, it creates the necessity of learning IoT for students while it creates opportunities for educators for effective teaching practices.

2. IoT IN EDUCATION SYSTEMS

Many educational institutions and educators are continuously exploring new opportunities and seeking new technologies to enhance the learning and teaching process. On the way of exploration, many educators found the IoT as an exciting option to incorporate in their educational activities. There are two major categories of IoT in education activities:

a) Adopting innovative ways of using IoT devices to enhance teaching difficult subjects with ease
b) Incorporating IoT courses in the curriculum

IoT devices are the additional feature in the existing digital technologies used in the learning and the teaching environment with the addition of interactive smart boards, smart multimedia pens/stylus, graphic tablets, document cameras, digital podium, clickers, interactive LCD panels, microphones, speakers, etc. The use of IoT devices will lead the classroom into the smart classroom. This will offer a higher level of personalized active learning environment for the students.

The other category of IoT is teaching IoT to the students of various backgrounds. For institutions with existing courses related to electrical, electronic engineering, programming, microcontroller architectures, robotics, and others have very much an open discussion question whether they need something in addition to teaching IoT (Lyzhin, Efremov, Rolich, Voskov, & Abrameshin, 2019).

For those who are not related to the above fields, it needs to be approached in a different way. Lyzin et al. (2019) had used the general approach to teaching IoT is to design extensible educational constructors for carrying out multidisciplinary practice sessions.

Many institutions offer IoT courses ranging from introductory to the advanced level depending upon their program and curriculum. Some institutions also offer specialized course on IoT as a certificate program.

Burd, Barker, Divitini, Perez, Russell, Siever, and Tudor (2018) discussed challenges and decisions involved in an initial IoT course offering and suggests the design of IoT curriculum and the selection of the tools for a quick start that suited to novice learners. According to their paper, existing course approaches are can be described in four categories as follows:

a) Category 1: Broad Introduction to Internet of Things Concepts in a Single Course
b) Category 2: Integrate IoT Concepts into Existing Courses
c) Category 3: Focused Course Intended as Part of an IoT Specialization
d) Category 4: Courses about Specific Use-Cases that Employ IoT

Most IoT courses are mainly focused and involved in the hands-on hardware-centric project. These projects consist of the following platform and tools:

a) Hardware Platform
   e.g. Arduino, Raspberry Pi, BeagleBone, Intel Edison, Microbit, Particle Photon, etc.
b) Software Platform
   e.g. C, Java, Python, etc.
c) Cloud Platform
   e.g. MQTT, CoAPP, HTTP, etc.
d) Network Communication Platform
   e.g. WiFi, Bluetooth, Zigbee, Z-wave, etc.
e) Components and Accessories
   Sensors, Actuators, jumper wires, breakout boards, push buttons, etc.

Most projects use one or more hardware and software platforms. Among these categories, the selection of the hardware platform is the most challenging. IoT hardware platforms are the mediums to establish a relationship between device sensors, actuators, and data networks to relay information. The two most popular and commonly used IoT hardware platforms are Arduino and Raspberry Pi.

Dobrilovic and Zeljko (2016) had proposed an IoT platform for university curricula using an IoT education kit consisting of an Arduino Uno board. Raspberry Pi is selected because of its low cost, efficient, and flexibility that can assist in introducing IoT the paradigm in the education system (Mahmood, Palaniappan, Hasan, Sarker, Abass, & Rajegowda, 2019).

The study by Zhong and Liang (2016) presents and provides the project-based teaching and learning approach devised in an IoT course for undergraduate students in computer science major using Raspberry Pi platform as an effective vehicle to greatly enhance students' learning performance and experience. The paper by Kurkovsky and Williams (2017) presents the experience of incorporating IoT projects into an existing Systems Programming course using Raspberry Pi. At the two-year college, the course on IoT introduces IoT platforms using Raspberry Pi and Arduino for non-majors in the hope of generating interest in the STEM fields (Maullett, 2018).

Raspberry Pi and Arduino platform are selected because of its huge community support, low-cost, open-source codes, and easy availability of many samples of IoT projects.

3. IoT EDUCATIONAL KIT

IoT educational kit consists of a set of components including breadboards, jumper wires, development controller boards, sensors, motors, and electric components like resistors, capacitors, inductors. Commonly used development boards are Arduino-Uno, Raspberry Pi, Intel Galileo boards, beagle bone, etc.

In the study by Ilia et al. (2019), most used educational projects and learning kits are mainly with the use of Arduino or PCBs based on the ESP8266. Kusmin (2019) had discussed the co-designing of the kits of IoT Devices for inquiry-based learning. Kits are designed by interviewing teachers and students from different schools for their choice of kits given the list of kits.

Preliminary projects are designed to learn the basic function of IoT devices. Some of such projects are:

a) Led Blinking
b) Dimming LEDs
c) Temperature and humidity reading
d) Activating/Deactivating relay switches

The advanced project for the next level of the project can be designed to solve real-time problems. Some of these projects are:

a) IoT based smart parking system using RFID
b) Smart irrigation system using IoT
c) Cloud based temperature monitoring system
d) Smart streetlights
e) IoT based smart fire alarm system
f) IoT Face Recognition AI Robot

These advanced projects are designed that uses tremendous applied research skills and use of kits to solve real-time problems.

These IoT educational kits can be categorized into two groups.

a) Raw kits that do not come with instruction and the uses of components are completely depends on the students' and educators' instructions.
b) All-in-one Educational Kit that comes with full instructions of assembling the given project along with all hardware and software components. These kits are often called as do-it-yourself (DIY) kits or IoT development kits or IoT starter kits.

These kinds of kits come as all in one packet kits along with all the required components and step by step instructions. Most of these kits come with a smart phone app that allows easy connection with preloaded projects. Example of such kits are

a) SparkFun IoT Starter Kit with Blynk Board
b) Osoyoo Robot Car Starter Kit
c) Makeblock Ultimate 2.0 10-In-1 Robot Kit
d) Sunfounder Robot Raspberry Picar-S Kit
e) Lego Mindstorms EV3 kits

These development kits are suitable for the entry-level learners of IoT. So, these types of kits are used by the high school students and STEM students of non-technical majors, beginners of programming. These are also useful for the business who are stepping in the IoT technologies.

4. BENEFITS OF EDUCATIONAL IoT KITS

There are several benefits of adopting Learning IoT Kits. Some of these benefits are as follows:

- There are many kits available in the market which can be selected based on affordability.

- Educational kits are available for different age groups and learner groups.
- Educational kits are very suitable for the beginners since it does not require much experience. The kits come with step by step instructions and online tutorials are highly available.
- Most of the Kits come with cloud application integrations.

5. CHALLENGES OF EDUCATIONAL IoT KIT

Some of the challenges of educational kits are as follows:

- There are many available DIY kits available in the market and it will be hard for the beginner to know which one to choose.
- The cost of the kits may range from $60-$200. These costs may not be affordable for some students.
- Troubleshooting the hardware components could be difficult to diagnose for the beginner.
- Some IoT devices and applications may not be compatible making it difficult to deploy.

6. CONCLUSION

The increased use of IoT devices has attracted the attention of many sectors, including the education sector. The need for innovative teaching methods is imminent because of its diverse nature. Learning Kits serve learners at all levels. There are numerous educational kits available for beginners, advanced users, and applied researchers.

There are enormous opportunities for adopting educational kits for the learners. Making use of education kits speeds the learning process and the realization of the potential of IoT. Increasing awareness and knowledge of IoT across disciplines could lead to the development of new smart things. The dreams of a smart world may become reality.

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Investigating Student Behavior in an Interdisciplinary Computing Capstone Course

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Abstract

Interdisciplinary project teams are increasingly vital in organizations that are focused on providing successful technical solutions that include a positive user experience. In response to the need for experience in this area, some higher education institutions have created interdisciplinary project-based experiential learning opportunities. In this research, we examine an interdisciplinary computing capstone course and present results from a qualitative study of student participants. We investigate how teams in an interdisciplinary capstone course self-organize, what convictions drive these decisions, and how they assess and value the expected contributions from disciplines other than their own. We analyze students' attitudes, beliefs, and motivations as gleaned from interviews and offer suggested improvement strategies for future interdisciplinary capstone courses.

Keywords: interdisciplinary, experiential learning, capstone course, computing

1. INTRODUCTION

In higher education technology degree programs, it is common to provide a team-based capstone experience that serves to give upper class students the opportunity to synthesize solutions to novel problems from a knowledge base acquired across their entire curricular experience. The benefits of this approach, and of team-based experiential learning in general, are well-understood and well-documented (Brooks, 2017; Carrasco et al., 2016). In such courses, students earn important perspectives on the interconnected nature of seemingly disparate technology knowledge areas and are better prepared for navigating the workplace and/or future graduate studies.

A common concern with capstone course experiences in computing fields is how to provide an effective real-world experience given the inherent lack of discipline diversity. Most technology degrees become increasingly discipline specific as students progress. Thus, the pool of students in senior-level courses from which team members are drawn is often limited largely or entirely to a single degree program. Any possible team roster will necessarily lack discipline diversity.

In response, some higher education institutions require interdisciplinary study as a significant component of their core curriculums. One such approach piloted at a University in the southeastern United States involves creating an interdisciplinary capstone course to increase interactions between multiple disciplines and represent an experience similar to the workplace where teams are composed of people with diverse backgrounds and skill sets. The capstone course serves as the culminating experience for an interdisciplinary program. In this case, the program is a joint effort by multiple departments: mass communication, marketing, design, and computer science. Students in the capstone course are a mix of students from these disciplines.

This paper reports on data gathered from semi-structured interviews conducted with students from the capstone course immediately after completing the course. It focuses on understanding team dynamics in an interdisciplinary capstone.

We are motivated by the following research question: how do teams in an interdisciplinary capstone course self-organize, and what convictions (especially what unsupported convictions) drive these decisions? Specifically, we seek to understand how students choose leadership roles, how they negotiate task assignments, and how they assess and value the expected contributions from disciplines other than their own?

This paper presents results from a qualitative analysis of student behaviors and motives. This type of analysis allows us the flexibility of openly exploring formative research questions and allows for future research to build on our results.

We identify some trends in student motivation and behavior that we believe are useful for informing academic stakeholders currently teaching or planning to teach an interdisciplinary capstone course. Section 2 presents a review of relevant literature, section 3 describes the course structure, section 4 describes the research methodology, section 5 describes our research findings, and section 6 provides lessons learned and presents suggestions for improving the interdisciplinary capstone experience. Section 7 suggests additional avenues for further research.

2. LITERATURE REVIEW

Teamwork is an important skill needed in the workplace (Abraham, et al., 2006; Drake, Goldsmith, and Strachan, 2006), and researchers have examined various aspects including satisfaction and productivity (Napier and Johnson, 2007), personality styles (Gorla and Lam, 2004), self-selected teams (Brabston and Street, 2005), and virtual teams (Chen et al., 2008; Goodbody, 2005; Nandhakumar and Baskerville, 2006). Additional research found that success in teams can be related to factors such as work ethic, equal contribution, and meaningful projects (Napier and Johnson, 2007; Ngai, Lok, Ng, Lo, and Wong, 2005).

From an educational perspective, research has shown that working in a team environment positively impacts student learning (Jensen, Moore, and Hatch, 2002). To help develop these skills, higher education institutions have introduced team projects and even entire courses that focus on developing teamwork skills. These efforts include components to ensure graduates possess effective communication and teamwork skills to adequately prepare them to be successful in diverse business environments.

James Shaw (2004) conducted a longitudinal study of 390 students examining the effects of diversity in project teams. The results of the study suggested student performance was significantly impacted by both the structure of the group as well as the position or role a student assumes within the group. Other research has focused on cohesion of interdisciplinary teams by improving communication and emphasizing the need for participation from all members within an interdisciplinary group (Becher and Trowler, 2001; Byram, 1997; Woods, 2007).

There are a number of recent education case studies on the benefits of interdisciplinary capstone courses and many of these cases indicate participants are better prepared for future workplaces and/or graduate school (Brooks, 2017; Carrasco et al., 2016; Flannery and Malita, 2014; Maloni, Dembla, and Swaim, 2012; White and Miller, 2015).

Kruck and Teer (2009) found that the student experience in an interdisciplinary technical capstone course was improved by including group activities about team success and establishing consistent group meeting times. Other case studies find that students generally have a positive view of interdisciplinary capstone courses (Heikkinen and Isomöttönen, 2015; Nettles et al., 2016; Smith et al., 2014) and interdisciplinary teams enable students to identify their own expertise and increase their occupational identity (Heikkinen and Isomöttönen, 2015). Spradling and Strauch (2010) presented a case study of an interdisciplinary course and found that less antagonistic attitudes were exhibited when a shared governance philosophy of managing the course was used.

Finally, our research also touches on how students perceive other students from different discipline areas. Research by Seipel and Brooks (2019) reviews the literature on academic entitlement and its effect on academic outcomes and also reports on a comparative study between business and non-business majors. In particular, they note that entitlement is related to inflated views of the self-concept.

Our research builds on these studies by directly investigating the motives and preconceived notions held by students in technology-focused interdisciplinary capstone course. We report on some noteworthy trends that inform course curriculum and philosophy.

3. INTERDISCIPLINARY COURSE STRUCTURE

In order to maximize the positive outcomes identified by the research into interdisciplinary capstone courses for students, it’s imperative that the course be carefully designed. It’s important that this experience be obviously different from a normal lecture course, focusing instead on modeled real-world experience, positive team experiences, and collaborative work on appropriately designed projects.

The following discussion about the structure of this course is provided, not because we intend to study the efficacy of this particular course design, but rather to demonstrate that students completing this course had ample opportunity in both preparation and course design to experience positive outcomes.

Students in the study course met regularly at an off-campus location for the entire day (9:30 a.m. to 4:30 p.m.) each Friday during the semester. Meeting off-site provided a clear indication of a different experience. Students spent significant time focusing on the semester group project, met comfortably with clients in conference settings, and worked to foment as a team (team lunches, etc.). The course content mimicked real-world experience by including daily scrum meetings and having all daily activities dictated directly by the needs of the project and client.

The course instructor(s) selected projects from the community and ensured they were a good fit for the interdisciplinary capstone setting. Projects were selected to offer opportunities for contributions from all four disciplines to provide a meaningful semester experience for all students. The instructor(s) ensured that each group had at least one student from each discipline and additionally worked to form the best possible teams given the nature of the project.

In most semesters, two instructors were made available during class time; one from design and one from computer science, as projects typically needed ample guidance in those areas. Additional instructors from the other disciplines attended on the first day to provide coaching and establish an avenue for communication throughout the semester.

Finally, each student who reached the capstone course was primed with an academic background that prepared them for maximizing outcomes from an interdisciplinary experience. Students who majored in the program began by taking a common core of classes across the component disciplines to build foundational knowledge in each area. Critically, each student was required to learn basic programming. Students then increasingly focused on their chosen concentrations and gained a depth of specialized knowledge and training. Students emerged from their specialized training and combined their diverse skills to form their capstone course project teams.

4. CASE ANALYSIS

To facilitate analysis of student motivations, decision-making structures, beliefs, and expectations we designed a semi-structured interview protocol (IRB approved) that was administered to students who were just completing their capstone experience.

Each interview began by asking students to review an informed consent agreement. The consent document described the scope of the study, indicated that there was no compensation of any kind, and informed that participation in the study was completely voluntary. Since the collection of data occurred after the conclusion of the semester, it was clear to students that their participation had no impact on grading or graduation. Once the student accepted the informed consent agreement, we started recording audio for later transcription and analysis.

To gather insight into student decision-making in choosing an interdisciplinary program we first asked students how they learned about the interdisciplinary program. We also asked their reason for choosing their major, their concentration, and for any general thoughts about the program. In addition to providing a valuable resource these questions served to establish a relaxed atmosphere where there were no "right" or "wrong" answers.

To evaluate group decision making we asked students to discuss the role they played in the project as they saw it, followed by a question about how they decided on the first task to complete. To better identify what role each student played we asked each to disclose all the tasks they personally performed throughout the semester to accomplish the group project.

Each student was also questioned about the major project tasks they did not participate in and asked to identify which students worked on that task and why. In cases where students from one or more academic concentrations were not involved in a task we asked why.

This gave us insight into not only why students worked on certain tasks but also why they did not. We also compared the provided answers and attempted to find correlation between chosen tasks and students' academic discipline.

Next, we asked students to predict what specific additional tasks they would have needed to accomplish in each of three hypothetical situations where their team would have been missing students from one of the three other disciplines. In each case, we asked them to rate their confidence in their ability to compensate for the missing expertise on a ten-point scale; ten being the most confident. In each case we also asked them to explain their rating.

To better gauge group-level decision making and to assess the assignment of leadership roles in the groups we asked students to consider how their group decided which tasks to work on and how they prioritized tasks. We also directly asked who the team leader was in their estimation, and asked what leadership qualities were valued most highly.

For this analysis, a single investigator conducted interviews with 10 students forming 3 teams. The class had a total of 13 students; however, 3 students were not available during the data collection. Of the 10 students in the study, five students were from computer science, two were from design, two were from mass communication, and one was from marketing. To ensure all teams had representation from all disciplines, some students served as the discipline expert on multiple teams. The investigator was given freedom to follow-up on any partial or unclear answer and could pursue interesting lines of reasoning with ad-hoc questioning. Each interview typically lasted 20-30 minutes. Each student was assigned an arbitrary participant identifier and each interview was audio recorded and transcribed using a professional transcription service.

To process these transcriptions, investigators independently employed open coding techniques to code a single interview transcript as provided by the interviewing investigator and developed a set of themes and codes. Next, three investigators independently coded the other 9 interviews. After the initial round of coding, the investigators worked together to unify codes and resolve discrepancies.

5. FINDINGS

The results show that students in the study group were both excited by and prepared to participate in an interdisciplinary group setting. In regard to the interdisciplinary program itself, we observed many general compliments and complaints typical of any program with no single deficiency standing out. Students listed job availability (n=4) and providing valuable information (n=3) as the most common strength of the program. Some students enjoyed the creativity afforded by the program (n=2). One student typified these feelings when he said, "Sort of just that merger between two different domains is what I really thought was the best, was perfect. It's so hard to find something like that out there. It's usually very technical, like just straight CS, straight CS engineering… a lot of depth but not very broad, and that's what I really liked about [the program]."

The results also show that students have been very intentional about the specific concentration they have chosen. In discussing the reason for choosing their concentration, students overwhelmingly cited a personal interest in the specific concentration (n=7).

The marketing concentration student primarily saw their contribution to the project as marketing, market research, and developing social media strategy. Design students saw their contributions as front-end design and HTML/CSS development. Mass communication students saw their role as content creation, client management, interaction design and sales. Students in computer science saw their role primarily as back-end development. The self-reported prioritized "first tasks" cited by students aligned typically with degree concentrations as well.

Tellingly, students in computer science also mentioned HTML/CSS, front-end development in Java-script, and client management among their primary contributions. The computer science students were unique in so far as they listed areas of expertise that crossed into the expected domain areas of the other disciplines.

This trend around self-reported contributions was born out when examining the role that students took in each group. Students tended to choose specific roles in the group in alignment with the curriculum of their concentrations and with their reported key areas of contribution. Again, the one exception was computer science students who also tended to take front-end development and client management roles; roles the investigators would have presumed belonged to mass communication and design. These discrepancies are interesting in and of themselves, but the potential impact to the success of the interdisciplinary experience comes into focus with further investigation of student motives and beliefs.

When we asked students who led their teams, every student indicated that their team was led by a member of the computer science concentration. More than half of the students cited effective communication(n=6), a skill set not stereotypically attributed to computer science students in general, as that person's key leadership quality. Half the students indicated their group leader was most knowledgeable and best able to mentor and answer questions.

On the surface, this is a glowing report reflecting well for the group of computer science students. However, when considering that the projects were chosen by the instructor(s) to provide ample experiential opportunity for all students, and weighing the intentionally diverse structure of the teams, this is not necessarily the best outcome for project success.

Survey results indicate an inequity between concentration specific self-efficacy as reported by students from outside concentrations. Appendix 1 illustrates that on a 10 point Likert scale (10 registering the highest confidence) students in the other concentrations felt confident in their ability to carry out the work of the marketing (m=7.7, SD=3.3), mass media (m=6.6, SD=3.5), and design (m=6.6, SD=3.5) students. Students outside computer science were far less confident about their ability to perform the task of the computer science students (m=3.4, SD=2.2). Moreover, the smaller standard deviation shows even less variance in students' low assessment of their ability to perform those tasks. These ratings were consistent for mean, median, and mode and showed only marginal differences between the three measurements. Despite the balanced nature of the selected projects we saw a clear differentiation of perceived importance of academic background between concentration areas.

Further highlighting these discrepancies were the results when students were asked to discuss the major tasks contributed by their teammates. We found that students overwhelmingly identified tasks that were performed by design and computer science students as major tasks and those by marketing and mass communications students as lesser tasks. This indicates that students from certain disciplines either were actually, or were at least perceived to be, more active in accomplishing tasks than others. This is not the anticipated outcome especially given that group projects were carefully chosen to engage all participants.

Analysis of interview data draws an interesting picture. The concentrations where students reported higher self-efficacy ratings were marketing, mass communication, and design, respectively. In each of these, data suggests that students are under valuing the expertise of others and overvaluing their own abilities.

For example, one student reported concerning the importance of marketing expertise said, "I could have just brought in a plugin or looked up how to do that (marketing). Analytics and AdWords, I understand how that works. Data analysis, we've done stats classes and stuff like that, maybe not specifically with this, but certainly I've had enough experience in doing it to where I could figure it out."

Another student acknowledged that they did not understand the marketing discipline, but then proceeded to show an undervaluing of that discipline specific knowledge. "I feel awful. Which is I don't exactly know all they do or all they've learned beyond search engine and optimization, but even the people that are in the capstone kind of felt confused about that, even the [computer science] kids sort of seem to know a little more about that than they did... "

Students also tended to assert a belief that domain knowledge in marketing was quickly attainable on their own with minimal effort. "If I do the research, I think I would be able to pick up all the necessary skills to accomplish that task." From another student: "... at the time, I was taking [a professor's] usability test class, so I had very fresh knowledge on how to do that. … It was all very fresh in my mind, on how to do everything for it.

This undervaluing of domain-specific expertise is not limited to marketing. In the case of mass media, we are able to observe similar attitudes. One participant noted, "Not trying to knock it, but it's not… I feel like I have natural skills to be able to do that stuff as well."

When discussing their confidence ratings for design, one typical student reported, "Yeah, I could do it, but I don't want to because I don't like the individual experience in what colors mean and positioning looks best." While design students do consider colors and positioning, their work is obviously far broader involving information flow, conceptual design, user experience, responsive design, programming frameworks, and typography. None of these were identified by students from the other disciplines. At least in the case of design, many students seemed able to admit a creative shortfall in completing design tasks, but even in so doing undervalued those tasks. One student wrote, "I think that, well personally like I want to do front-end development, so I have a lot of outside knowledge on coding the stuff, just not designing it. So the designs would take me longer than would probably take them, but in terms of usability, the way that it's coded, it would probably be a higher quality and take less time."

For the areas of marketing, mass communication, and design, students from other disciplines all showed a confidence in understanding what those disciplines entail, while simultaneously and obliviously exhibiting an outsider's limited viewpoint and expertise. That confidence in being able to encapsulate those academic areas in a few limited notions seems to boost their self-confidence that they themselves could fairly easily learn enough content knowledge to replace team members from those disciplines. Given the limited scope of what the students can report about what these academic areas even are concerned with, this seems less than likely.

The opposite is true, however, for computer science. Students outside the discipline don't think they understand what the discipline is about; at least not to the level that they feel confident they could learn to perform tasks specific to that discipline. We do not see the same undervaluing as with the other three disciplines, if anything, we observe the opposite.

When asked to qualify their low confidence in completing computer science related tasks students primarily cited a lack of knowledge or understanding (n=3) or lack of programming skills (n=2). One participant typified responses from almost all the others, "I mean I know that they do things, I want to make that very clear. I don't think they don't do anything. I just don't understand exactly what they do. I know that it's a lot of stuff that I would probably not even understand if they tried to explain it."

Obviously, these trends have negative impacts on the outcomes expected from interdisciplinary capstones. To track this, we asked study participants how their group interacted with each other over the course of the semester. Initially, some group members felt their groups started out with poor group cohesion (n=4), but most group members felt that their groups worked well together. A significant minority of group members (n=3) felt that the groups never achieved good group cohesion. "So [mass communication], and one of the, what's it called, [marketing] people seemed to not really know what they should be doing or had the appearance of working, but then if I ask them what they're working on, they'd ask like, 'What do you want me to do?' I was just curious; I didn't really have anything to give them." All three of these students came from computer science and had previously exhibited an undervaluing of the contributions from other disciplines. These three were not from the same group. Based on conversations from other team members, the negative feeling of poor cohesion was not shared by their teammates.

6. DISCUSSION AND PEDAGOGICAL IMPLICATIONS

In this section, we highlight the major findings from our analysis and offer suggestions as to how instructors can mitigate potential issues in the design and implementation of an interdisciplinary capstone course.

Overvaluing and undervaluing disciplines

We consistently found that team members from different disciplines either undervalued or overvalued the other disciplines. In our analysis, this phenomenon appeared to be the overarching concept that led to other issues within the team.

When we examined students' confidence in completing tasks related to concentration areas other than their own, we found unsupported confidence displayed in every concentration. Students tended to under-value the expertise provided by disciplines other than computer science, and often trivialized the value of the discipline specific domain knowledge.

To address this, we suggest great care be taken in the design of an interdisciplinary capstone course to emphasize the importance of each discipline in the success of the team. It is important that steps be taken early in the course to help mitigate these student perceptions.

Suggested improvement strategies:

1. Highlight real-world examples of projects that failed due to lack of involvement from all disciplines. For example, there are numerous examples of projects that met the basic requirements, but failed due to poor user experience, resulting in millions of dollars in losses.
2. Design discipline specific activities that showcase the knowledge and talents of each discipline. For example, create a task that highlights aspects of design, usability, or digital marketing.

Unbalanced leadership

We observed that each interdisciplinary team independently built an ad hoc hierarchy with the more `technical' disciplines at the top. This occurred despite the fact that all students were required in the shared curricular core to learn programming and despite the inclusion of additional web development courses in some of the less-technical concentrations.

Every student in every group in the study self-identified a student from the computer science discipline as their group's leader. Prior to this study, our expectation was that group leadership would naturally be uniformly distributed over all concentrations. We found this interesting as computer science students are not typically known as "charismatic" or " natural born leaders". Survey data suggests a two-fold reason for this. First, this likely results from the computer science student's overconfidence in their ability to complete tasks typically associated with the other disciplines. The effect is exacerbated by the other students' self-doubt in their ability to learn to complete more technical tasks.

Suggested improvement strategies:

1. Include activities that highlight important leadership qualities and strategies for selecting team leadership. Make sure that students understand that technical ability and/or overconfidence is not necessarily a good leadership quality.
2. Introduce real-world examples of how poorly chosen leadership doomed projects, and how technical projects are often led by people without deep technical backgrounds.

Team Cohesion

To maximize positive outcomes, teams need to exhibit a unity of purpose as soon as possible. Students need to begin building team cohesion on the first day and continue strengthening that cohesion throughout the semester. Our results showed that some team members felt their team never reached a satisfactory level of group cohesion.

We posit that better group cohesion is more likely when group members respect one another and believe that different disciplines are equally important to achieving the goals of the group. Our research indicates that more emphasis and improved teaching methods are needed to help students internalize that all disciplines are essential to the project and that there are important outcomes above and beyond merely completing the project.

Suggested improvement strategies:

1. More emphasis on the importance and value of interdisciplinary teamwork needs to start early in the program(s) of study and be maintained throughout the higher education experience.
2. Include activities focused on the respect of the ideas and abilities of others. Highlight real-world examples where these principles were not followed leading to failed projects or disastrous consequences.

7. CONCLUDING REMARKS

Interdisciplinary capstone courses provide learning opportunities and experiences that augment what is available in a siloed degree program. We examined one such capstone class and found that students sought out the program because of their desire to broaden their knowledge and take advantage of the unique learning environment. We also found that despite efforts to foster appreciation for the equal value of different disciplines, students created an ad hoc discipline hierarchy. Unfortunately, this led to undesirable effects such as limiting learning opportunities, lack of diversity in group leadership, greater reliance on faculty for guidance, and a perceived lack of group cohesiveness, each of which hampered the development of expected positive outcomes and undermined critical teamwork experiences.

We find that additional work is needed to convey the idea that the breadth of interdisciplinary knowledge is critical to project teams and that each discipline is of equal value. The perception that a student–and the concentration they represent on the team–could be replaced by a mere software plugin is an example of how trivialization of another discipline can negatively impact team productivity and attitude. Future research is needed to examine additional mitigation strategies for overcoming false perceptions concerning the value of different knowledge areas. This will require building an inclusive culture that is cultivated from the first moment a student expresses an interest in the interdisciplinary program.

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Appendix 1

Table 1: Confidence ratings (1 to 10, 10 being Very Confident) of performing discipline-specific tasks as reported by students in one of the other three disciplines.

	Number of Ratings	Min	Max	Mean	Median	Mode	SD
Marketing	9	4	10	7.7	7	7	3.3
Mass Communication	8	4	9	6.9	7	7	3.2
Design	8	3	10	6.6	6.5	6	3.5
Computer Science	5	1	4	3.4	4	4	2.2

Moving to Business Analytics: Re-Designing a Traditional Systems Analysis and Design Course

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Abstract

Many traditional Information Systems (IS) programs are either redesigning current courses to incorporate business/data analytics or expanding curricular offerings to include business /data analytics; our IS program chose the former route to meet the demand (from employers) for business/data analytics. In that transition, a traditional systems analysis and design (SA&D) course was redesigned to focus on the procedures and skills needed to perform business/data analytics; this required changes to the focal topical areas. In 2017-18, curricular changes transitioned a traditionally focused database systems analysis and design course to incorporate business/data analytic skills. This paper focuses on the course redesign and the new business/data analytic topics, activities, and technologies; we highlight the important shifts created to the topical areas of this course. The paper emphasizes the rationale and student outcomes generated.

Keywords: Data/Business Analytics, Pedagogy, Systems Analysis and Design, Structured Data, SQL

1. INTRODUCTION

Over the past decade, Information Systems (IS) programs have been adjusting to meet the growing demand by industry to produce business analytics/data science professionals (Mills, Chudoba, & Olson, 2016). This has required a change/addition of courses that meet the need for the skills of these professionals (Radovilsky, Hegde, Acharya, & Uma, 2018). In addition, “there are a growing number of degree programs, specializations, and certificates in data science and data analytics at both the graduate and undergraduate levels” (Davenport & Patil, 2012; Dumbill, 2013; Aasheim, Williams, Rutner, & Gardiner, 2015).

Our undergraduate program decided to revamp the IS curriculum to address the change in skills. The first change occurred in existing courses in the business foundation. Our business foundation is unique, we did not have a traditional three credit hour Introduction to IS course, but instead all students complete three IS-related courses. The first course in this sequence was a formal Systems Analysis and Design course. This course culminated in students designing a simple database in Access.

The sophomore level Systems Analysis and Design (SA&D) course was re-focused and re-titled Data Collection and Modeling; this paper focuses on the changes made this SA&D course.

When designing this course change certain areas of the SA&D process were preserved due their importance in capturing the structured data used in business analytics; namely requirements analysis and data modeling; we discuss each area in a later section of the paper. In addition, new areas—data literacy, data curation/metadata, data quality and cleansing and SQL—were added.

This paper is structured in the following manner. In the next section, we describe the primary learning objectives of this newly designed course; including the areas of SA&D that remain due to their importance in the data/business analytics process. In section three, the importance of focusing on data literacy is examined. Section four continues the data literacy discussion with the introduction of the two major models that form the basis for this newly developed course; the data life cycle model of Chisholm (2015) and the CRISP-DM model for data analytic problem solving (Chapman, Clinton, Kerber, Khabaza, Reinartz, Shearer & Wirth, 2000). In section five, we address the primary pedagogical approach used to introduce the skills-based modules of the course. In section six, we describe the major topics explored throughout the course. These topics include project management, data curation and the use of metadata, data cleansing, data modeling and data structuring, data analysis using the CRISP-DM model, and data retrieval using basic SQL commands. In the seventh section, we examine the major project that is undertaken (in teams) by the students to gain hands-on experience. In the final section, we state some concluding remarks by discussing the impact and major outcomes of the course for the students. In addition, we address some future work that needs to be undertaken.

2. COURSE LEARNING OBJECTIVES

The newly designed Data Collection and Modeling course required a complete reworking of the course learning objectives. For this redesign effort the work of L. Dee Fink (2013) was utilized. Fink's taxonomy of significant learning includes six critical areas to consider when designing a course for significant learning impact. These areas are: foundational knowledge, application, integration, human dimension, caring, and learning how to learn. Fink believes that a course that addresses each of these categories will create a lasting change in the learner that will be important to the learner's life. In particular, we, when designing this course, envisioned that change to be one of understanding the importance of leveraging data to solve business problems.

A primary goal of the course is to begin to introduce students to the basic skills necessary to become a data literate member of a data-driven society. The concept of data literacy is not new and not limited to data analytics. The primary definition of data literacy used for the course is given by Wolff et al. (2016). Data literacy is "the ability to ask and answer real-world questions from large and small data sets through an inquiry process, with consideration of ethical use of data" (Wolff, Gooch, Cavero Montaner, Rashid, & Kortuem, 2016, p. 23). Students "need to have at least a basic understanding of the concept of data, and they need to be able to understand and engage with data fitting their role and start talking the language of data" (Goodhardt, Lambers, & Madlener, 2018, p. 1).

The new course learning objectives are:

1. Identify the data literacy skills necessary for your given profession.
2. Utilize Microsoft Project, Microsoft Visio, Microsoft Access and basic SQL commands to answer business questions using data from a project domain.
3. Develop a multi-part report that describes how your data activities addressed the selected business questions
4. Employ and advance your written communication skills in conveying technical information.
5. Demonstrate and advance your teamwork skills in working through a data-intensive project.

In order to achieve the first learning objective, we strive to produce students that at least meet the minimum data literacy requirements of their chosen major field. This includes acquiring the basic foundational knowledge necessary to function productively in their first employment opportunity. The second learning objective deals with the application (skills) that the student will obtain through the course. This learning objective deals primarily with Fink's (2013) areas of providing foundational knowledge, the application of that knowledge and the ability to learn how to learn especially in dealing with new skill development. These areas were chosen based on the work of authors who had addressed the specific skills necessary for today's data scientist. (Dumbill, 2013; Goodhardt, et al., 2018; Mills, et al., 2016; Radovilsky, et al., 2018). The third learning objective deals with the team project assigned in the course. This project work will encompass the integration of the knowledge and skills through application, human dimension in understanding how to function as a productive team member, caring, about the work and the people on your team and learning how to learn category through the work of the project. The final two learning objectives are included to fulfill of both the University's Central Curriculum and the business school's AACSB learning objectives. These objectives are most concerned with integration of knowledge and the human dimension in terms of both written communication and teamwork skills.

In addition to these learning objectives, we identified a set of conceptual and constructive take-aways for each student; these take-aways are shown in Appendix 2. These take-aways highlight more specific skills learned in the course. The learning objectives were developed using the current literature on analytics skills (Dumbill, 2013; Mills, et al., 2016; Radovilsky, et al., 2018) and in consultation with recent alumni in the business analytics and related fields. The skills were deemed appropriate for a first course in business analytics, taught to all business students, in the business foundation of the program.

3. DATA LITERACY

In 1992, Peter Drucker, in an article in the Wall Street Journal (Drucker, 2005)), explained that data users—executive or professional—need to be data-literate and decide what data to use, what to use it for and how to apply the data to solve problems. For organizations to prosper in a data rich environment, "*every organization, in every industry, should adopt a data-literate culture" (Smith, n.d.).*

The development of data literacy requires individuals to acquire skills in two areas. First, individuals must be able to understand and appropriately use tools and technologies for data analysis and decision-making. Second, individuals "need to learn to think critically and analyze data to choose the correct data and the suitable analytical and presentation methods for the situation" (Smith, n.d.).

This course module begins with two separate readings on data literacy to familiarize the students with the need for data literacy and a data culture, to provide a basic understanding of data literacy, and to show how data literacy is germane to the various majors with the business curriculum. The essence of this discussion is summarized by the figure in Appendix 1 which is taken from Goodhardt et al. (2018).

To further enhance data literacy skills assignments are used so -students practice using tools—Microsoft Project to create and update a project plan, Excel for data cleaning, Microsoft Access to structure data, and SQL to create queries—that allow students to fulfill the technology component of data literacy.

To improve the critical thinking and data analysis skills of the students, individual assignments in data cleaning, database development, and SQL statement development, and project assignments problem statement development, selection and matching of potential data sets for analysis, data cleaning, database development, and SQL statement creation.

Another aspect of data literacy that is covered in this module is the life cycle and use of data. Students are introduced to the two models which are described in more detail in the next section. Through data life cycle (Chisholm, 2015), the students are presented with a model of how data is typically handled within the business environment; the model describes seven stages within the life cycle of data. The CRISP-DM model (Chapman, et al., 2000) is also introduced—although to lesser extent. The model illustrates the application of data within a problem-solving process. The concurrent examination of these models exhibits the important business processes undertaken within overlapping intervals of these models; as stated earlier the discussion on the overlap of the models is a work in progress.

One final discussion area in this module is the development of a data strategy as proposed by DalleMule and Davenport (2017). The article reveals the two intertwined sides of a data strategy: data offense and data defense. Data offense, which is the primary focus of their project work, deals with how an enterprise uses data to "support business objectives such as increasing revenue, profitability, and customer satisfaction. Data defense activities ensure compliance with regulations and minimizing downside risk. Data defense shows the ethical implications that are addressed in data literacy (Wolff, et al., 2016) and includes discussion of data governance issues.

Data literacy, the data life cycle model, the CRISP-DM model and data strategy are topics that will be revisited throughout the course as they set the foundation for the student's understanding of how data "should be" viewed and handled within and enterprise.

The primary assessment vehicle for the understanding of data literacy is a short reflective paper (two to four pages). The students are asked to identify the activities and topics that were covered in the course that contribute to building their data literacy skills foundation. The students are asked to put themselves, in their chosen major, along the scale shown in Appendix 1 and discuss the level of proficiency and their projected data role. The reflective assignment is used as the final individual learning assessment to gauge each student's depth of knowledge attained through the course and work on the team project.

4. DATA AND DATA-DRIVEN DECISION-MAKING

When examining data and data-driven decision-making it is often helpful to examine existing models that describe these processes. In particular the examination of the data life cycles within an organization and the data-driven decision-making process.

In examining the data life cycle, one particular model that is most useful is the data life cycle (DLC) model proposed by Chisholm (2015). Chisholm proposed a seven-stage model of the data life cycle: capture, maintenance, synthesis, usage, publication, archival, and purging. The data life cycle does not necessarily define all the specific processes involved in handling data, it does provide "high-level", i.e., strategic, understanding of the activities within that stage regarding enterprise data; the stages are shown in Figure 1 and discussed in more detail in Chisholm (2015) and Pomykalski (2020).

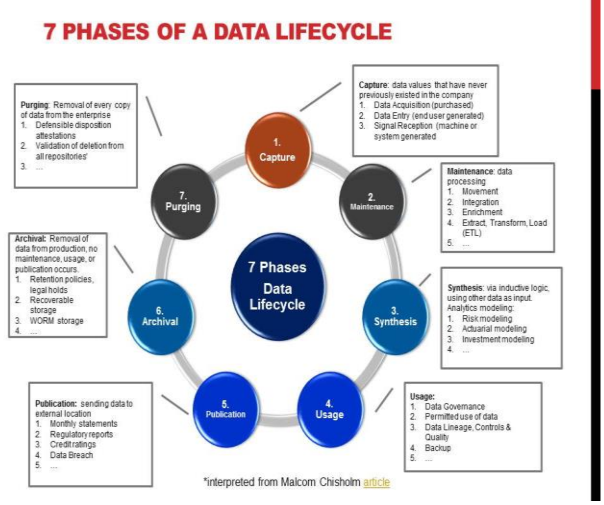

Figure 4: Stages in the Data Life Cycle

On the other hand, the analytics problem-solving process is best described by CRISP-DM model which was developed through a partnership led by DaimlerChrysler. The CRoss-Industry Standard Process for Data Mining (CRISP-DM) methodology, developed in 1996, is "based on the practical, real-word experience of how people conduct data-mining projects" (Chapman, et al., 2000, p. 3). The CRISP-DM methodology (see Figure 2) consists of six stages: business understanding, data understanding, data preparation, modeling, evaluation, and deployment.

These two models, blended together, form the basis of the course. The primary objective of which is to introduce students to the use of data to solve business questions. While a preliminary understanding of the integration of these models has been developed the formal description of the integration is considered future work.

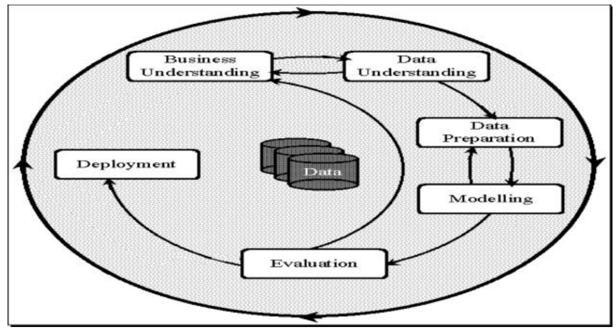

Figure 2: Stages in CRISP-DM

5. GENERAL PEDAGOGICAL APPROACH

As described in the previous sections, the course covers several topical areas relevant for understanding and sufficiently comprehending the business/data analytics field. In the sections below, we describe the topical areas and justify their inclusion in the course.

Before examining the course topics, a brief discussion of the pedagogical approach taken to enhance the learning of the students is essential. For the major, skill-based modules within the course (project management, data cleansing, data modeling, data structuring and data retrieval), the course is designed to follow a similar pattern in the student learning experience. Each module is designed and introduced using a similar pattern:

1. The module is introduced through a reading(s) with an in-class lecture and discussion to clarify the topic;
2. Students are then engaged in a low-stakes, in-class assignment as practice (discussion of the frequent, low-stakes (FLS) assignments is given below);
3. Students are then given an individual assignment—with a more complex problem as a graded element; finally
4. Students then perform the same assignment, within the context of their team project.

For the skill-based modules, the method of FLS graded assignments is used (Warnock, 2012). This is done, as stated by Warnock (2012) as a means for student to build confidence that they are performing the task correctly and as a means to communicate and clarify any misunderstands or missteps apparent in the assignments. This is important because after the low-stakes assignments, the individual and team-based assignments carry larger weight in the overall grading of the course.

6. TOPICAL AREAS

Within the current course there are two topical areas that are largely addressed as general topic areas (data literacy and data curation/metadata) and five skill-based areas. The five skill-based areas all follow the pedagogical approach outlined in the section four. While data curation/metadata can be viewed as a skill-based area, the pedagogical approach is focused more on the work done as a project team and not individually.

Project management

Project management has been deemed as an important skill for all students within the business foundation and was made part of the original SA&D course; it has carried over into the business analytics curriculum. Knowledge of project management is vital for students to manage the significant number of course projects that they have each semester within their business foundation courses and for their work in their career.

Within this module, students gain basic knowledge through readings, chapters from Heagney (2016) and FSL assignment in developing both a work breakdown structure and the Gantt chart for short case study. In addition, the students create a work breakdown structure for their team project, based on the overall project description, and create a Gantt chart in Microsoft Project that must be updated throughout the semester; this is done to track the project deliverables.

This learning module and work on the project allows each student to not only understand the vocabulary and basic activities performed in the management of project work, but gain understanding as to how their individual contribution to that work enhances not only their individual learning but their team development.

Data curation and metadata

Data curation is a data management activity that plays an important role in the data life cycle. Data curation is "the work of organizing and managing a collection of datasets to meet the needs and interests of a specific groups of people" (Wells, 2019, p. np). Data curation is performed prior to the start of the data analysis process; it is the identification and structuring of the data pertinent to the data analysis process. The primary purpose, according to Wells (2019), of data curation is to make datasets easy to find, understand and access. Data curation activities are performed primarily by problem domain experts and those ensuring metadata quality.

Metadata, or "data about data", is vital in the use of data driven solutions in enterprises. Metadata contains information that not only describes the data, but includes the type, length, and previous use information; this is captured in many modern data catalogs (Villanova University, 2019). Data curation and metadata development are important in the metadata management process.

The students develop knowledge of the importance of metadata to the business problem-solving process primarily in the team project by examining data dictionaries to find pertinent data fields. They must differentiate between descriptive, structural, and administrative metadata and apply the three types of metadata to their project work by reading and utilizing a data dictionary that is provided (Villanova University, 2019).

Data quality/data cleaning

"In the case of business analytics, or the study of data and what information can be gained from the data, the 80/20 rule becomes: 80% of the time spent by a data scientist is on gathering, cleansing, and storing the data, while 20% of the time is spent on analyzing the data" (Snyder, 2019, p. 23). While gathering and storing are explicit parts of the data life cycle process, Snyder (2019) points out that data cleansing has often been granted a "lower status" in the data quality activities within business analytics. However, given the importance of data quality in the business analytics process it should have a more prominent role in the overall data life cycle.

In this course we dedicate an entire module to data quality and data cleansing. Through a reading and a class discussion the importance of high-quality data for decision-making is stressed. The students are then introduced to a number of basic Excel techniques that can be used in the data cleansing process with any size data sets. Excel is used, in this course and subsequent business foundation courses, as part of a business school wide plan to incrementally build the student's knowledge and proficiency with using Excel as a tool in solving business problems. Again, a low-stakes in-class assignment is used to assess their initial understanding.

A data cleansing activity highlights the work in this module and the students are expected to repeat the data cleansing process within their data analytics project; see section seven. The data cleansing activity—a specific tutorial in Monk, Brady, and Mendelssohn (2017)—focuses on finding missing data, inconsistent data (based on data type), duplicate records, formatting issues, incorrect entries based on spelling mistakes, and simple logic errors. The students create an error log which utilizes a different type of entry for each particular error type. A class discussion that focuses on the remedies for each type of error follows the work on the class activity. An individual assignment with a larger dataset is given to determine their skill development in Excel and understanding of the data cleansing process; a key output is the development of the well documented error log.

Data modeling

Within a data analytics project, the data model is most critical model for the understanding of the structured data necessary for solving the business problem. Data modeling is a "technique for organizing and documenting a system's data. A method for the representation of organizational data" (Whitten & Bentley, 2008, p. 270).

The primary model that is used to capture the entities and the business relationships between the entities is an entity-relationship diagram (ERD). The entity-relationship diagram is "a data model utilizing several notations to depict data in terms of the entities and relationships described by that data" (Whitten & Bentley, 2008, p. 271). The students use traditional SA&D readings to understand and develop an ERD through the in class exercise. Coverage of all the elements of the ERD—entities, attributes, relationships and cardinality—are addressed. The individual assignment used is a carryover from the SA&D course in which the students develop both the model and a business memo to describe the major elements of the ERD (Pomykalski, 2006).

The students, within the context of their project also design and develop a data model specific to the data selected to address the chosen business problems and create a new memo, using the same structure, to discuss the ERD development process.

Data structuring/analysis

Having the ability to structure data in a simple database application is important to all students regardless of the particular business discipline. In this course, Microsoft Access is used to structure the project data.

The students are introduced to Microsoft Access though a set of in-class and individual assignments taken from the Monk, et al. (2017). These assignments give the students the basic skills necessary to create relational database tables, forms, queries and reports. The students learn to move Excel data into tables, and then perform basic data analysis functions.

One of the fundamental Excel skills introduced in this module is the use of Excel pivot tables as a means for further exploration and analysis of the data. This again is covered through tutorial in Monk, et al. (2017). The basic skills developed in this module also followed the prescribed methodology laid in section five.

The CRISP-DM model is also examined in this module of the course. The students examine the particular activities that occur in the later stages of the model dealing with data preparation, modeling, and evaluation.

Data retrieval—SQL

The final learning module of the course is focused on the development of an understanding of basic SQL commands. This is the first introduction to SQL commands that students receive, and it was implemented in this course due to feedback from alumni that were obtaining first jobs in a variety of different majors. The knowledge of SQL to find and extract data for their new teams was seen as an enhancement to the role they could fill directly after graduation.

This three-week module includes introduction to a basic SELECT statements and the ability to perform many simple extraction and summarization functions. In particular, the module covers the initial half of the Forta (2013) text on SQL. In particular, we introduce commands for: data retrieval, sorting, filtering, manipulation, summarizing, grouping and table joins. This module does not cover the development of a database structure using SQL.

Again, this skills-based module follows the same pedagogical structure described in section five, however, since each new function needs to practice, a series of in-class assignments, each with newly understood functions, are provided in a low-stakes assignment format.

7. PROJECT WORK

One of the primary learning assessments in the course is the work done through the team project. The team project is a full semester project which has multiple intermediary deliverables that help comprise the overall grade for this component. Teams of three to four students work through the various activities that mimic the skill-based modules in the course. The project idea and the necessary business questions and data are taken from the Teradata Analytics challenge. Each of the two projects that are currently available have been used without significant overlap due to the richness of the business questions and the vast amount of data that is available to the students. The project, the description of which is given as Appendix 3, includes a number of activities for the project team to undertake.

The students begin the project by creating an overall project management plan for the undertaking of the project. The first activity is to review and select two business questions, these are provided as part of the Teradata Analytics Challenge; the students are encouraged to review the data that is associated with the particular business questions. An in-class review and discussion of the data sets (along with the corresponding data dictionary) is undertaken.

The first project deliverable includes (1) a written description of the selection of the business questions and their significance, (2) a work breakdown structure including the rationale for many of the project management decisions, and (3) a Gantt chart that schedules each of the particular activities on a semester long timeline.

In part two of the project, the students turn their attention to closer examination of the data sets that they have chosen for their particular business questions. The students are asked to explore and cleanse the data sets. They must provide a detailed account of the activities that they undertook in the examination and data cleansing work. The final stage for this work is to structure the selected data fields into different data sheets within Excel to facilitate the import of the data to a Microsoft Access database structure.

In part three, the students are asked to model the data and create an ERD that shows the data in clear logical, well organized structure. The students must define the data entities, attributes, relationships, and cardinality. The deliverable for this stage is the memo and ERD model for their project data similar to the deliverable for the individual assignment (Pomykalski, 2006).

The final activity that is undertaken within the project is the development of the SQL queries needed to examine the data and answer the business questions. The final deliverable—the final written report—incorporates the discussion on the development of the SQL queries as well as summarizing all of the work undertaken in the project.

The project gives the students the experience of providing a final client driven report that summarizes all of their activities over the course of the semester. The students also gain experience creating intermediate, progress reports that can be provided to the client and the project team as a means for documenting the work. The students are allowed to utilize the previous (corrected) reports to create the final project deliverable.

8. CONCLUSIONS/FUTURE WORK

The transition of a traditional IS curriculum to a business analytics curriculum requires a substantial amount of rework and new thinking as to the topics and pedagogies used. However, not all of the traditional IS concepts need to be removed. As we have shown, both project management and data modeling have been revised to focus on the data aspects of the analytics process.

In this paper, we examined and described this transitional work—we continue to tinker with many areas—and this new structure seems to serve the students well. We have had a number of students go into both internships and employment opportunities with these new skills and that feedback from these students has been positive.

Analytics is a field that continues to evolve and therefore the evolution of this course and subsequent courses in the business foundation will require close scrutiny and monitoring in the coming years. The integration of the data life cycle and the CRISP-DM models are future projects so that students can investigate the complexities of the business/data analytics process.

We are pleased with the progress we have made thus far and we believe that these courses will better serve our students are they undertake new employment opportunities as both interns and permanent employees.

9. ACKNOWLEDGEMENTS

The author would like to acknowledge the contributions of the other faculty, both current and recently retired, in the development of this course redesign and the establishment of a recently created major in business data analytics. As new faculty have recently joined our ranks we look forward to their contributions to the continual development of this course and expect to be able to provide updates of these development efforts in the near future. In addition, we appreciate the comments and feedback of the reviewers.

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APPENDIX 1: Relation between Data Literacy Levels of Proficiency and Data Roles

(Goodhardt, Lambers, & Madlener, 2018)

Level	Definition
Conversational	Basic understanding of the concepts of data, analytics and use cases; one who "gets it" but cannot explain it to others
Literacy	Ability to speak, write and engage in data and analytics programs and use cases
Competency	Competent of designing, developing and applying data and analytics programs
Fluency	Fluent in all three elements of information language across most business domains within an industry vertical
Multilingual	Fluency across all three elements of the information language across multiple business domains, industries and ecosystems

Data Believer

Data User

Data Scientist

Data Leader

APPENDIX 2: Course Take-Aways

Conceptual Take-Aways	**Constructive Take-Aways**
Develop a data literacy mindset	Use Microsoft Project to manage a data analysis project
Examine data through a forma data life cycle	Compile a large dataset, clean and structure the data
Relate the roles and responsibilities involved in data management	Develop/enhance your Microsoft Excel skills
	Load data into a Microsoft Access database
	Write SQL queries to produce answers to business questions
	Produce a formal written report explaining the results of your queries in addressing the business problems.

APPENDIX 3: Course Project Description

Analytics Project

Objective: The goal of this project is to create a data analysis report. To be able to do this, you will chose two business questions, identify, organize, clean and normalize data relevant to the business questions, load the data into a database, develop SQL queries, create charts, and detail your analysis in a written report. You will choose your own teams of 2-3 people.

Project: The general description of this project is given at:
https://www.teradatauniversitynetwork.com/Community/Student-Competitions/2019/2019-Data-Challenge

The business questions for this project reside in a file on Blackboard; under the Analytics Project folder. There are five major categories of questions listed: Client Services, Volunteer Programs, Development, Employer Partnerships and Opportunities, and Serving Spouses Program. Your team is to pick a category and within that category, they will select at least two questions to investigate further.

The General Task (From Teradata Challenge submission template):

1. State and describe your understanding of the business question(s) you are addressing.
2. Choose the datasets provided by the Hiring Heroes USA organization from Teradata that are most appropriate to address your business question(s). Similar to an SQL query:
    a. Identify the field names and values that you need to address each business question.
    b. Identify the data sets that have related fields to those that you need to address the question.
    c. Clean the datasets to make them consistent in form and format.
3. Provide an Entity Relationship diagram of your relevant data.
4. Design SQL queries to address each question from the cleaned and structured data.
5. If you cannot run your queries, describe what you expect to get (estimate your results)

The Specific Deliverables

I. **Team Sign-Up**: This is the simplest of the deliverables for this project. Each person enrolled in the course must get into a team with one or two other people currently enrolled in the course; preferably in the same section. Once the team members have agreed to become a team, one member of the team must send me an EMail that lists the members of the team.

Due Date: Friday, September 20, 2019

II. **Plan**: There are two deliverables associated with this stage.

a. A document describing the selection of the category and the two business questions your team will address and your rationale for your choices. You should clearly state the questions and then describe, in your own words, your understanding of those questions.

b. A Microsoft Project file containing the work breakdown structure of tasks, precedence of tasks, who completed each lowest-level task (resource) and duration (time) to complete each task. In addition, you need to provide a document that describes your decision making process in completing this project management task.

Tentative Due Date: Wednesday, October 9, 2019

III. **Microsoft Excel File(s):** The data with each worksheet cleaned and normalized as a table suitable for importing to Microsoft Access. There will be two deliverables associated with this activity.

a. Your team will produce a **progress report**, which will outline the selection of the data sets, field names and values that you have identified, and the activities you have undertaken, to date, on the files and the work that still needs to be completed.

Tentative Due Date of Friday, October 18, 2019.

b. Upon completion of the work with the data files your team will create a document which describes all of the activities you performed on the data sets to put the data into a consistent form and format.

Tentative Due Date of Monday, November 4, 2019.

IV. **Microsoft Visio ERD:** There will be two deliverables associated with this stage.

a. Your team will produce a business memo that explains the entities, attributes, including primary keys, relationships and cardinality depicted in your ERD. Make sure that the relations are normalized to at least Third Normal Form (resolve all many-to-many relationships with associative entities).

b. Create an entity relationship diagram using Visio. For full credit, make sure cardinalities are valid and display with crow's feet for the "many" side.

Tentative Due Date: Wednesday, November 20, 2019

V. **Microsoft Word Report**: Report summarizing what was done that includes:

a. The questions being addressed and your current understanding of these questions.
b. A corrected, updated version of your Microsoft Excel file activity report.
c. A report that describes the SQL queries that your team created, the rationale for each of those queries and the results (or expected results) from those queries. You are to include a discussion on how your team expected the queries to address the particular business questions.

Tentative Due Date: Monday, December 9, 2019

VI. **Individual Files**: Send both as attachments to an e-mail.

a. Microsoft Excel Peer Evaluation: Download the file from Blackboard. **Be aware**, awarding all members all 4s for all criteria will be worth 0 points.

b. Microsoft Word Reflection: The personal statement should include a half-page (in length) to one page document reflecting on the experience of doing this project (what parts of the project were your responsibility, what you learned, what parts of the project would you improve, …).

Tentative Due Date: Wednesday, December 11, 2019

Grading:

Requirement:		Poss. Points:
I.	Team Sign-Up	2
II.	Plan (MS Project File)	17.5
III.	Cleaned and normalized Data [MS Excel File(s)]—Including both reports	24.5
IV.	ERD (MS Visio File)	15
V.	Analysis Report with Charts/Graphs (MS Word File)	26
TEAM GRADE		**85**
VI.	Individual files (to be e-mailed)	
	1 Personal Statement (MS Word)	
	2 Peer Evaluation (MS Excel)	
INDIVIDUAL GRADE		**15**

Please note: that while each team member will likely receive the same score for the team based portion of this project, individuals grades for the team component are adjustable (mostly downward) based on an individual's contribution to the team deliverables. The impetus for this point deduction will come from discussions with team members and the two evaluation documents shown above.