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TiPS for Surviving Pandemic Teaching: A Learner-Centered Framework

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Abstract

The COVID-19 pandemic in Spring 2020 necessitated a sudden shift to online learning. Faculty at Saint Michael's College, in Colchester, Vermont (USA), had ten days to re-plan their courses as well as potentially learn new pedagogies, adapt to technology for instruction, and help students adjust to the changes. In addition, faculty needed to prepare for the likelihood of at least some online teaching in Fall 2020. Applying a structured approach to course design for online and hybrid instruction was accomplished for the authors' courses in business administration, computer science, and information systems by reworking a framework derived from the first author's previous research. This paper explains the framework and offers examples of class projects and assignments that were effective in achieving learning outcomes for both the remainder of the online Spring 2020 and the online and hybrid Fall 2020 semester. Successes and challenges from this application and ideas for future research are discussed.

Keywords: Course design, framework, COVID-19, course projects, sample assignments

1. SUDDEN SHIFT TO ONLINE

The public health emergency in March 2020 required Saint Michael's College's administration to make expeditious decisions for faculty to teach and students to learn safely in the face of a fast-moving deadly virus (Jasick & Redden, 2020; WHO Timeline, n.d.). Saint Michael's is a Catholic, residential, small liberal arts college, located in Vermont (USA). We offer 39 majors in 19 fields of study, including Business Administration, Computer Science, Data Science, and Information Systems. Business Administration is the College's most popular major, representing 20% of the 1,500 student enrollment. Information Systems and Data Science majors are inter-disciplinary offerings where the core courses are drawn from Computer Science and Business Administration or Computer Science and Statistics, respectively.

Due to the COVID-19 pandemic, higher Education changed instantly (Jaschik & Redden, 2020), and faculty, many of whom had never taught online, had 10 days during the semester's spring break to take their fully residential, in-person (i.e., Face-to-Face or F2F) classes online using instructional technology tools, video conferencing applications, and Canvas by Instructure, the College's learning management system (LMS).

Whether courses are offered in person, online, or in any combination of the two, effective learning results from careful instructional design and planning (Weimer, 2013). While typical planning for online teaching is six to nine months (Hodges, Moore, Lockee, Trust & Bond, 2020), our instructional technologists arranged ongoing support for online instruction to begin following the semester's spring break. Faculty scrambled to prepare to deliver classes from home (or from

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within closed offices). Lansford (2020) and Flaherty (2020) stated that faculty needed to find ways to balance both practical and technical aspects of their work and home life. All classes at Saint Michael's remained online for the duration of Spring 2020.

The Registrar reported about 30% of the faculty and 15% of the students remained fully online for the Fall 2020 semester. Fall 2020 classes that were face-to-face followed a hybrid model, where some students were in the classroom and others attended online to accommodate state-mandated safety protocols of 6 foot spacing between people. At week 9 in Fall 2020, the College had to shift to fully online due to an increased number of COVID-19 cases.

The remainder of this paper addresses how we used a framework from previous research to shape online instruction in Spring 2020 and online and hybrid instruction in Fall 2020. The paper addresses successes and challenges of balancing instructional technology, educational process, and people (i.e., students and faculty) in business administration, computer science, and information systems courses.

The courses covered in this paper are briefly described in Table 1 below.

Course	Description
Strategic Management – Business Administration (Popovich)	Undergraduate senior-level, writing-intensive course. Discussion, experiential, & case-based. Serves as an elective for Information Systems. Two sections of 18 students both semesters.
Introduction to Computer Science (Pangborn)	Introduction to programming in Java. Spring 2020 had 27 mostly first-year students.
Computational Methods for Data Science (Pangborn)	Python language basics needed for data analytics. Spring 2020 had 22 students.
eCommerce (Pangborn)	Survey of web programming tools and related topics including electronic payment, copyright, and security. Fall 2020 had 12 students.

Table 1: Courses Spring 2020 and Fall 2020

2. PEOPLE, PROCESS, AND TECHNOLOGY

During the 10-day spring break that preceded returning to instruction in March 2020, we examined best practices (see for example, Centre for Innovation in Teaching and Learning, n.d.), reviewed course design rubrics (see for example, Canvas Course Evaluation Checklist review by Baldwin & Ching, 2019), participated in informal faculty conversations via Facebook Group pages, and learned about discipline-specific approaches and resources through the SIGCSE-listserv (Special Interest Group in CS Education). For well over a decade, many instructional models have been introduced for faculty development centering around topics such as mentoring, engagement, technology, and assessment (META) (Dittmar & McCracken, 2012) and learner-centered approaches to teaching (Weimer, 2013). Reviewing multiple models for our courses revealed several concepts to incorporate for online and hybrid learning:

- keeping a learner-centered design;
- offering project-based experiential learning;
- adapting to constantly changing instructional technology;
- supporting students in asynchronous and synchronous environments;
- retaining assessment and outcomes.

Clearly these concepts focused on the integration of students and faculty with educational processes and appropriate use of technology. The People-Process-Technology (PPT) framework proposed in Popovich's previous research, Chen & Popovich (2003), was based on the then emerging research in Customer Relationship Management (CRM) (See Figure 1).

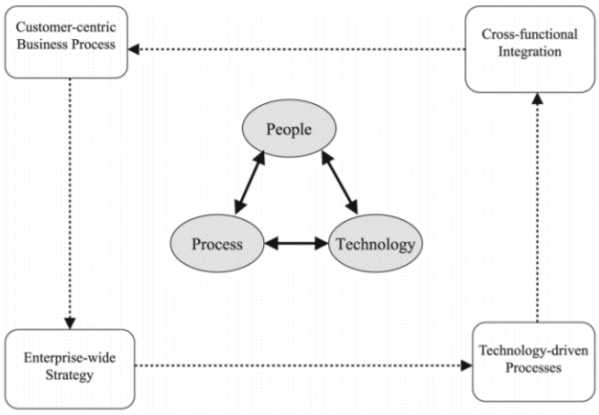

Figure 1: People-Process-Technology (PPT) Framework (Chen & Popovich, 2003).

The proposed PPT framework in the CRM paper was part of a comprehensive, cross-functional, and enterprise-wide strategy to develop innovative customer-centric and technology-driven business processes continuously aimed to fit customer needs and to optimize profitable relationships.

There was a need for a systematic, yet flexible approach to Spring 2020 online and Fall 2020 online or hybrid instruction that was innovative and adaptive (Rapanta, Botturi, Goodyear, et al., 2020), technology-driven (Bates, 2003), pedagogically sound (Tennyson & Schott, 2010), learner-focused (Weimer, 2013), and designed to achieve course learning outcomes (Dittmar & McCracken, 2012). With a few modifications, the People, Process, and Technology model described in Chen & Popovich (2003) was generalizable to the current situation of online, and hybrid education. In the adaptation, referenced as TiPS for **T**echnology (**i**nstructional), **P**edagogy, and **S**tudents/Faculty, the goal was to maximize the learning environment for students, achieve learning outcomes, and ultimately, optimize students' academic performance. The adaptation from PPT to TiPS is explained in Table 2.

PPT Framework	**TiPS Framework**
People	***Students and Faculty***
Process	The learning process is accomplished through ***Pedagogy***
Technology	***Instructional Technology*** tools available to faculty to design, implement, and evaluate courses.
Customer-centric business process	**Learner-centered**
Enterprise-wide strategy	**Department & course learning outcomes**
Technology-driven processes	**Technology-enabled**
Cross-functional Integration	**Integration of theory to practice**

Table 2: PPT to TiPS

The adapted TiPS model is shown in Figure 2.

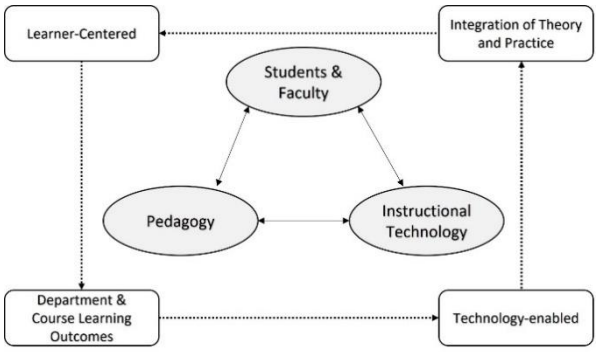

Figure 2: TiPS: Technology (instructional), Pedagogy, Students & Faculty

In summary, the adapted framework integrates three principal components: Students and Faculty, Pedagogy, and Instructional technology. Balancing the three components requires a learner-centered approach to achieve department and course learning outcomes through technology-enabled tools, and assignments and projects that apply theory to practice. The arrows in the model, like Chen & Popovich (2003), indicate a philosophy of continuous evaluation and improvement. The next section explains each component in the framework.

3. TiPS Framework

Approaching the switch to online for Spring 2020 and recognizing that the upcoming Fall semester was likely to be a mix of hybrid or fully online, it was important to discover ways to foster better teaching and learning (Adkins & Tu, 2021). With an eye towards creative opportunity and a desire to focus on innovation, the adapted model inspired research and learning to build effective courses to help students achieve established learning outcomes.

People: Students & Faculty

Hodges et al. (2020) concluded that the migration to online learning created disruptions to students, staff, and faculty lives outside the educational institution. Faculty had to consider a number of factors, such as class size, learning objectives, and content, to determine whether synchronous or asynchronous learning was more effective for their courses. In addition, the choice was also influenced by students' personal situations, which may have been challenged by varying technical skills, access to technology, connectivity, work and family obligations, physical learning environment, and individual learning styles. Deadlines, policies, and assignments all required flexibility. Faculty had to balance teaching, research, and service obligations and quite

possibly had to learn completely new pedagogies and techniques to implement digital technologies (Rapanta et al., 2020). A disadvantage of online learning is the lack of F2F instruction, so configuring the learning environment to foster exchange of ideas and information requires faculty buy-in and a strong organizational structure (Sagheb-Tehrani, 2009). Chen & Popovich (2003) had noted the importance of top management support and a commitment to CRM throughout the organization.

Weimer (2013) distinguished "learner-centered" from "student-centered" to keep the focus away from the notion of students merely being "customers" (see also Searcy, 2017). Instead, Weimer (2013) placed the focus on students as "learners," who were supported by practices and policies that directly affected learning. There was no shortage of tips (i.e., Bates, 2003) or instructional design models (i.e., Tennyson & Schott, 2010 and Brookfield, 2017) to assist faculty in their course design and assessment.

Additionally, faculty and students had to adjust to physical and emotional conditions and constraints. It was not even clear that the online environment was conducive to learning (Lederman, 2020). Boardman, Vargas, Cotler, & Burshteyn (2021) surveyed students on performance and feelings of connectedness to peers and faculty in their online classes. Their small sample determined that feeling connected to peers decreased after switching to online learning. Within the adapted TiPS model, our courses addressed the challenges students and faculty faced by keeping a learner-centered focus on design, implementation, assessment, and revision.

Process: Pedagogy

According to Chen & Popovich (2003), CRM systems allowed companies to integrate business processes to understand and respond to market changes. Selecting from a combination of potential instructional materials (i.e., videos, recorded lectures, homework problems, readings, and programming lab assignments) and types of interactions (i.e., discussions, presentations, virtual break out rooms, and peer reviews) required matching content knowledge to department and course learning outcomes. These efforts often required ongoing flexibility and immediate adjustment (Coman, Tiru, Mesesan-Schmitz, et al., 2020). In addition, clearly communicating requirements to students, often via multiple channels, was key to staying aware of evolving student needs (Rapanta et al., 2020). In a recent review, Adkins & Tu (2021) identified both successes and challenges to the sudden shift to online learning. A key takeaway: there is no one-size-fits-all model for the successful switch. Keeping students (learners) at the center of the course, learning to modify (or simplify) expectations, helping students adapt to technology, and allowing them to participate actively in their learning processes are considerations for course structure and design when shifting to online learning (Adkins & Tu 2021, Rapanta et al., 2020).

The expectation that the liberal arts will provide a return on investment and real-life work experiences has been repeatedly discussed in the literature (Cole, 2012; AACU&Y News, 2020). Pre-COVID-19, the Strategic Management course had already integrated instructional technology tools with project-based learning. A benefit of project-based learning for students is the integration of theory and practice which allows authentic opportunities for them to gain knowledge, work independently, and gain critical skills potential employers seek (i.e., Rice & Shannon, 2016). In preparing for online instruction, planned, semester-long experiential-based projects had to be adapted. However, it was important for projects to remain focused on learning outcomes that advanced students' professional development as well developed their critical thinking, problem-solving, and communication skills. For example, one pre-COVID-19 project required field interviews with managers. Since organizations were occupied taking immediate actions to protect employees, establishing response teams, keeping contact with customers, ensuring their own liquidity, stabilizing the supply chain, developing contingency plans, and demonstrating purpose (Staples, 2020), it seemed prudent to not add additional networking requests by students. However, creating opportunities for discussion on business responses to COVID-19 was a way to adapt and approach revised assignments. See a sample discussion topic in Appendix 2.

Technology: Instructional Technology

The College adopted Zoom video conferencing software. Khare & Popovich (2021) published a classroom decision-based case on the switch to online instruction, Zoom's explosive growth, and best practices for video-conferencing. In Chen & Popovich (2003), information technology optimized interactions both internally and externally. A goal our instructional technologists set for faculty was to consider whether and how instructional technology could support learning outcomes. For example, in the Computer Science

courses, consideration was given to appropriate communication tools. Slack, with persistent chat rooms organized by topic, private groups, and direct messaging (https://slack.com), was selected to streamline communication for online students. While it was yet another piece of software to adopt, students were receptive to it because it was a common industry tool.

Recent surveys of executives regarding student skills in a post-pandemic workplace (i.e., Lieberman, 2021) indicate that in addition to problem-solving, critical thinking, innovation, creativity, agility, empathy, flexibility, and growth mindsets, there is increased demand for using tools that facilitate human connection and collaboration. Digital fluency was also included as important to acquiring and keeping jobs. Being able to "combine" and "manipulate" information to solve complex problems have "tremendous value in the hiring market" (Chau, 2019). Within the adapted TiPS model, it is important to NOT assume that students are familiar or comfortable with the various instructional technologies. Allowing time to ask questions and offering resources on how to use the tools effectively are important. The Strategic Management course included video introductions to all instructional technology tools in play.

Continuous Improvement

The arrows in the TiPS model indicate continuous improvement through evaluation and revision. Chen & Popovich (2003) identified an ongoing evaluation loop around the entire CRM process: from design to feedback to evaluation. Instructional design is also a continual process. One model to consider is ADDIE (Analyze, Design, Develop, Implement and Evaluate) (i.e., see Kurt, 2017 for an overview of ADDIE). The TiPS evaluation process recognizes that Instructors often make incremental revisions and on-the-fly modification, especially for online learning. Another key takeaway is that what works really well one day, such as a collaborative discussion, may be ineffective the next. The TiPS framework recognizes the changing needs of learners and offers faculty flexibility in the design and regular reflection of progress towards learning outcomes. Instructors who demonstrate a genuine commitment to learning motivate students and impact their learning (Weimer, 2013). In the Spring 2020 section of Intro to Computer Science, having students work on practice problems in Zoom break out rooms completely bombed; the students were disengaged, and the instructor was out of the loop. Two simple fixes implemented in the subsequent offering made a tremendous difference:

1. Students worked in Google Docs which allowed the instructor to observe progress and to engage with students to offer real-time hints and feedback, and
2. At the start of each session the students were asked to adopt roles including facilitator, scribe, and reporter (whose task was to send a de-brief email to the instructor).

The second strategy came from pedagogical resources on Process Oriented Guided Inquiry Learning (Hu, Mayfield & Pearce, 2017).

4. PUTTING TiPS TO WORK

Some of our faculty were fortunate in having had experience teaching online from summer programs or from other institutional experience. Norton & Hathaway (2015) note that some faculty gain insight from observing their own online teachers. Many of our faculty relied upon the College's instructional technologists for assistance. College faculty decided whether synchronous or asynchronous models, or a blending of these modalities worked for their outcomes and students' needs. Sections of Strategic Management used a combination of synchronous in-class meetings via Zoom, and asynchronous individual and collaborative group assignments and projects during both semesters. In the Computer Science courses, classes were synchronous, though some days were a brief lecture followed by independent lab work. Boardman et al. (2021) noted that students, overall, felt more connected to professors after the switch to online learning. When participants in Boardman et al. (2021) were asked what tools helped them to feel more connected to their peers and their professors, the most helpful tool reported was Zoom.

When classes resumed in mid-March 2020, the environment could be described as chaotic and stressful. Students were riding an emotional rollercoaster of worries. Additionally, every course they were taking was set-up differently. It was also clear their faculty had different comfort levels with online teaching and the instructional technology tools. The authors' courses were already "heavy users" of Canvas, in that even prior to the pandemic, we made regular use of instructional technology tools (such as publisher and instructor content, video capture, discussion boards, solution sets, and detailed programming samples). The start of Fall 2020 was also a challenging time as students had to adjust to taking classes which were a combination of online, face-to-face, and hybrid.

On March 19, 2020, it was almost like the first day of class, all over again. Each instructor had to explain the systematic approach taken to redesign their courses. We reviewed the revised syllabus. In the Strategic Management course, some assignments that were not as critical to learning outcomes were simply dropped, and others received significant revisions to adapt to our new learning environment. Using Zoom's breakout rooms, in-class "project workdays" were added to the schedule. Typical lecture content was moved to video with either out of class written or video discussion boards or in-class small breakout room group discussions with "lessons learned" shared to the entire class. However, we stayed true to the course learning outcomes, with an emphasis on applying practice to theory.

A student commented, "the flexibility of the professor and her desire to see us succeed is what was really most effective. I appreciated the built-in workdays to collaborate on projects and presentations with peers."

The assessment components for the Computer Science courses had to be significantly reworked because they contained closed book in-class exams and finals. The software for supervising exams would not have been feasible for students with poor internet connections, and the instructor was also concerned with the privacy implications of this software. The instructor also wanted to avoid assignments that would increase the temptation for academic integrity violations, and therefore favored open-book assignments, additional opportunities for collaboration, and more low-stakes feedback. This redesign made a deliberate tradeoff to try to maximize learning at the expense of a possible compression of the final grade distribution. This approach seemed to work well; one student noted: "She allowed for a lot more collaboration among students which was great because it showed me that she really just wanted to make sure that we continued to learn despite the circumstances."

5. TiPS IN Action

The following offers a review of assignments and projects during the two-semester period. Each assignment indicates its focus on the balance of students/faculty, pedagogy, and instructional technology. These assignments can be adapted to a variety of courses and course levels.

Connections – Focus on Students
The Liberal Arts College experience promotes community relationships and close connections between students and faculty members. That connection was immediately changed with the start of the Pandemic. Virtual connections and various communications with students were frequent and deliberate. A Strategic Management student wrote, "Even though it was a lot of work, what helped was that the professor knew how to navigate the online class and teaching atmosphere. The breakout check-in discussions at the beginning of class gave me peace of mind knowing there was support for me if I needed it."

Post-Class Check-ins – Focus on Students
In the Computer-Science courses, students were asked to complete a check-in following each lecture. In the first check-in the instructor solicited information about concerns regarding resources and connectivity needed to continue the semester remotely. For the first few weeks the students were asked to indicate:

- Progress on their coursework
- Challenges with the material or other logistics
- What worked well or was particularly interesting.

After a couple weeks the prompt was changed to give the option of entering "no news" (which was taken to be good news). The instructor always answered these check-ins later that evening, and for the students who were interested in more conversation outside of the class, this proved a nice venue for that correspondence.

Collaborative Check-ins – Focus on Students
In Strategic Management, on that "first" day in March 2020, and in every synchronous class period thereafter, the first order of business, ranging from 10 to 15 minutes, was to have small group check-ins and an opening collaborative assignment using one of the applications from Microsoft Office 365. Casual discussion at the start of synchronous classes was also recommended by Boardman et al. (2021) stating that students felt motivated in online classes when assigned discussions and group work.

Students were assigned to randomly or pre-set breakout rooms with the suggestion to first "Take 3 minutes" to:

- share a good or happy event or news
- describe a challenge, struggle, or concern
- offer support to one another

Students evaluated the courses highly and commented in evaluations that they appreciated the caring and supportive environment created, which allowed people to connect, even though we were online.

One student stated, "the professor acknowledged that we may be struggling with adjusting to the new ways of classes. This was helpful as we had to move back home and adjust to home life. By getting us talking in small groups on how we were doing, it was encouraging."

Short Written Assignments & Peer reviews – Focus on Pedagogy

In Strategic Management, students analyzed secondary research to write a one-to-two page, single-spaced executive summary for each of three assignments, which when put together formed a case analysis for a selected company. For this project, students were divided into three different teams of six for the purpose of peer review. Each team was assigned a large public company from a list of options; the teams and the selected company remained the same for three writing assignments. Students were encouraged to communicate with one another and to help each other research and organize each of the short papers. The instructor expected students to submit their own work. Appendix 2 describes each writing assignment.

Each student was tasked with peer reviewing the other five people in their team. Assigning peer reviews in Canvas grants access to the peers' submitted files and students can add comments and attach files for each peer. A company-specific rubric was provided to the students. Following the due date, students had at least four days to read their peers' papers and offer substantive, productive comments on the rubric by the next class period. After reviews were submitted, we used breakout rooms for each group to discuss "what was done well," "what could use improvement," and "what did you learn for the next assignment." These "lessons learned" were then shared with the larger class in the main discussion room.

Analyzing the scores from four semesters –two without peer reviews and two with the peer review process– identified a positive, statistically significant difference in graded papers for the courses with the peer reviews (Popovich, *in preparation*). Students commented that they appreciated the opportunity to improve their grade with each short paper and to hear from others. A few students also mentioned spending more time editing because "peers would review their work." An additional comment mentioned "our small group built a learning environment that was both positive and collaborative."

Pandemic Strategy Project – Focus on Pedagogy

The pre-COVID-19 comprehensive project in Strategic Management was to have students, in small teams, build their professional network and meet a business executive or business professional in an executive leadership role. The project, approximately 30% of the final grade, was designed for students to witness how strategic management theories were actually practiced. After studying the selected company, the student team would then interview the professional. Finally, the team would moderate a live, 30 to 45 minute in-class video conference as a panel presentation with prepared questions asked to the business professional. A final presentation would include a written analysis as well as a reflection on lessons learned. Students were encouraged to search out companies and individuals that were aligned with their own career interests.

The project's experiential component with the business executive had to be canceled due to business professionals managing their own COVID-19 crisis situations. Instead, we adapted the project to focus on what businesses were doing to manage the crisis. The assignment was called "Pandemic Strategy." The project evaluation was re-weighted to account for 15% of the final grade, rather than the 30% originally assigned. New, shorter, collaborative video projects and discussions were put in its place. Students in both semesters were creative with these projects and were able to apply benchmarks for comparisons within the industry.

Programming Projects – Focus on Pedagogy

While compassion was crucial at the start of the pandemic, the students still deserved ample opportunities to master the course material. In particular, the instructor was concerned that students have skills to succeed in subsequent courses that relied on the material. The revised syllabus included "short assignments" where the programs were to be completed during the class periods. These programs were collected so the instructor could provide the feedback that would normally be provided informally in the lab. The instructor also added some zybooks reading assignments (with integrated activities) when the company generously made materials freely available for emergency remote (online) learning.

The normal weekly programming assignments were maintained, but students were explicitly encouraged to collaborate. Communication was crucial for minimizing student frustration, and

students were appreciative of this work. "She made herself available on Zoom, Slack, and e-mail during our class periods. While working on assignments, if I had a quick question or needed more explanation, I could send her a message and she'd get back immediately. She also had us check in with her after every class to just give her an update on how we were doing." The assignment write-ups were also expanded to pre-emptively include sample code, hints, and answers to questions that were most likely to arise in the lab period.

Creative Discussion Boards & "Our Take" Lecturettes – Focus on Instructional Technology

The Business Administration department had, several years ago, designed "Guidelines for Effective Discussion Board Participation" for use in summer online courses (see Appendix 3). Included in the guidelines is the requirement to follow a structured routine for all discussion board assignments:

- **POST** to the board by a certain date;
- **RESPOND** to the posts of a pre-determined group; by a certain date; and
- **REPLY** to all those that took time to write a comment to their post by the time the board closed.

The **POST-RESPOND-REPLY** cycle is repeated for all discussions. Students appreciate the routine of established due dates for each segment. In addition, these guidelines removed frustration felt by the students who posted their answers in a timely fashion and then had to wait for others who seemed to always post just as the discussion closed. Finally, the **REPLY** portion verified engagement when students took time to read what other students took time to write.

A faculty colleague was invited to record "Our Take" lecturettes as an alternative to a traditional single-instructor recorded lecture. Each "Our Take" was approximately 15-to-25-minute conversational overviews of the assigned readings which ended with our impressions on how the readings/theory applied to the business world. Students enjoyed the dialog of these brief before-class videos and in class were assigned to small groups to answer several questions about the readings.

Integration of Theory and Practice – Creating Balance with TiPS

Our over-arching teaching objective is to help students develop into graduates who bring their heads and hearts to work and recognize the value of being life-long learners. Part of this process is for students to enhance their abilities to assess situations from a variety of lenses from their liberal arts studies, to offer recommendations, and to evaluate their actions within a larger social context. Brookfield (2017) addressed critically reflective teaching from four complementary lenses: students' eyes, colleagues' perceptions, theory, and personal experience. His definition of critical reflection was the sustained and intentional process of identifying and checking the accuracy and validity of our teaching assumptions. Brookfield (2017) suggested we need to examine our assumptions, constantly inquire, and practice our work through the four lenses.

All assignments in our courses are attached to course learning outcomes which are matched to department learning outcomes. We examine our courses through four cornerstone touchpoints: student evaluations; faculty observation and pedagogy discussions; networking with business and community leaders; and alumni connections. These touchpoints allow us to evaluate how projects and assignments integrate theory with current business practice and trends. Using the TiPS framework helped us to balance course design, outcomes, assignments, and assessments from the viewpoint of a critically reflective teacher (Brookfield, 2017).

6. ADAPTING TiPS TO OTHER COURSES

There are numerous instructional design models to choose from in the research within business and computer science sub-areas as well as general higher education fields (i.e., Tennyson & Schott, 2010). While all models offer general guidelines to organize pedagogical content to achieve outcomes, the TiPS framework, with its emphasis on learner-centered approaches to match pedagogy to learning outcomes enabled through instructional technology, can be easily adapted to any introductory, lecture, discussion, programming, or writing-based course. Keeping TiPS in mind allowed us to make quick adjustments in an unprecedented environment where student needs seemed to change by the moment. The framework allowed us to adapt to different student learning styles and implement multiple methods to achieve our learning outcomes.

7. LIMITATIONS & FUTURE DIRECTIONS

The People-Process-Technology framework in Chen & Popovich (2003) focused on improved profitability with a cross-functional, enterprise-

wide strategy to optimize customer-centric and technology-driven processes. The TiPS framework offers a dynamic model for faculty by keeping a learner-centered focus that balances technology and pedagogy for the sudden switch to online education and the intentional online and hybrid planning for Fall 2020 (and beyond). The pandemic pushed Higher Education to assess their online learning programs and resources. Designing, developing, and evaluating online content, regardless of delivery mode, creates opportunity for faculty to collaborate and learn from each other.

Instructors with less experience with instructional technology tools may feel that TiPS requires additional support and training before adapting the framework in their courses. TiPS as a framework needs further research to determine its efficacy and its potential impact on students' academic performance. The next step for this research is to introduce TiPS to other faculty and determine how the model can be implemented in other courses from our respective programs as well as in other academic disciplines.

In some ways, 'Pandemic teaching' has taught us a lot and hopefully made us better instructors, but we welcome the opportunity to again share cookies or a meal to solidify our connections to our learning community.

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Appendix 1

Source: McKinsey's Briefing note #2, March 9, 2020. See references (Staples, 2020) for the link.

Learning Objectives:

1. Analyze organizational context, strategy, operations, processes, and performance; and
2. Identify and analyze current business practice responses to the COVID-19 pandemic

Directions:

1. Join one of seven breakout rooms in Zoom, each room number is associated with a response/action number in the table below.
2. Review the Briefing Note #2 article, discuss with your group, and give supporting examples of your assigned response/action.
3. Prepare 1-2 slides on your findings
4. We have 15 minutes to prepare this discussion
5. Share with the class in the main Zoom session

COVID-19 response: Companies can draw on seven sets of immediate actions.

1. **Protect employees**
   - ✓ Follow the most conservative guidelines from leading health authorities (e.g., CDC, WHO)
   - ✓ Communicate with employees frequently and with specificity; support affected employees.
   - ✓ Benchmark your efforts to determine the right policies and levels of support
2. **Set up cross-functional response team**
   - ✓ Overall lead should be at the CEO or CEO-1 level; team should be cross-functional and dedicated
   - ✓ Create 5 workstreams: (a) employees; (b) financial stress-testing and contingency planning; (c) supply chain; (d) marketing and sales; (e) other relevant constituencies
   - ✓ Define specific, rolling 48-hour and 1-week goals for each work stream based on planning scenarios
   - ✓ Ensure a simple but well managed operating cadence that is output and decision focused.
   - ✓ Present minimum viable products with milestones and progress dashboards as well as a trigger and threat map
3. **Test for stress, ensure liquidity, and build a contingency plan**
   - ✓ Define scenarios that are tailored to the company.
   - ✓ Identify variables that will affect revenue and costs. Use analytics and expert scenarios
   - ✓ Model cash flow, P&L, and balance sheet in each scenario
   - ✓ Identify moves to stabilize organization in each scenario
4. **Stabilize the supply chain**
   - ✓ Define extent and timing of exposure to areas that are experience community transmissions (tier -1, -2, -3 suppliers, inventory levels)
   - ✓ Immediate stabilization (ration critical parts, optimize alternatives, pre-book air/freight capacity, increase priority in supplier production, offer supplier support
   - ✓ Medium/longer term stabilization (updated demand planning and network optimization) drive resilience in supply chain network
5. **Stay close to customers**
   - ✓ Immediate stabilization (inventory planning, near-term pricing, discounts)
   - ✓ Medium/longer term stabilization (investment and priority targets for long-term growth)
6. **Practice plan with top team through in-depth tabletop exercise**
   - ✓ Define activation protocol for different phases of response (contingency planning only, full-scale response, other)
   - ✓ Key considerations: clarity on decision owner (ideally a single leader), roles for each top-team member, "elephant in the room" that may slow response, actions, and investment needed to carry out plan
7. **Demonstrate purpose**
   - ✓ Support epidemic efforts were possible
   - ✓ Retool manufacturing (e.g., produce PPE)

Appendix 2

Strategic Management Short Written Assignments & Peer reviews.

Description
Each group of six students will be assigned a public company. Using the strategy tools and frameworks discussed in class, three short topic research papers will address (1) What is the company's present situation; (2) Where does the company want to go; and (3) How should it get there? Together, the topic papers provide the basis of a company analysis to assess a company's current strategy, its superior profitability, and its sustainable competitive advantage.

Following submission in Canvas, peer reviews are assigned, and students are to complete a peer review rubric with formative comments for each assigned review. We will debrief the peer reviews at the next class period following the assignment's due date.

Learning Objectives:
1. Apply tools and frameworks by analyzing a selected company's business strategy
2. Offer critical and professional feedback for peers
3. Apply "lessons learned" to future writing assignments

Grading:
- Topic 1: 5% of the total grade. Value 100 points. 75 points assigned to the paper and 25 points assigned to the peer reviews.
- Topic 2: 7% of the total grade. Value 100 points. 75 points assigned to the paper and 25 points assigned to the peer reviews.
- Topic 3: 8% of the total grade. Value 100 points. 75 points assigned to the paper and 25 points assigned to the peer reviews.

Topic Descriptions:

Assignment Topic	Brief Description
Topic 1 SWOT/Mission/Vision/ Sustainability	Conduct a *SWOT* analysis and summarize your findings. Evaluate the company's mission/vision and sustainability efforts. Evaluate whether the company has a sustainable competitive advantage and demonstrates superior profitability. *SWOT* (strengths, weakness, opportunities, and threats)
Topic 2 External Analysis	Analyze the company's industry with a macro analysis such as *PESTLE* and Porter's Five Forces. Analyze the competitive marketplace with benchmarking. Does your research suggest that the firm's competitive strategy is working? Provide evidence. *PESTLE:* (Political, Economic, Social, Technology, Legal, Environment)
Topic 3 Financial Analysis	Using 5-years of publicly available financial data, analyze the company's financial position and recent trends with ratio analysis. Make strategic recommendations based on your analysis. Include your Excel file.

Appendix 3

Guidelines for writing an effective online post

1. Each discussion involves three actions with defined due dates: **POST** your answer to the question. **RESPOND** to others. **REPLY to** those that took time to respond to you!

2. Do not procrastinate. Follow the Canvas Calendar **Post-Respond-Reply** due dates.

2. Use business language. Do not use informal or texting language. Limit first person (I, my, we, our) since the idea is to discuss theory and not to express opinion (unless asked for your opinion or reflection). Use Spell check. Suggestion: Write your post in Word or Docs first, save the file, and then copy/paste to the discussion post. Canvas can be picky, especially for Mac users.

3. Engage in the topic. You have to be "all in" to get the most out of the online learning environment. If you find you are struggling with staying focused: contact your professor(s). We will contribute to keep the discussion on pace or to change direction, but do NOT expect a regular response from the faculty: this is YOUR discussion board!

4. We do not have access to "nonverbal cues" such as nodding our heads in agreement. The online discussion is a way for you to interact and engage with the entire class. Be courteous and respectful. REMEMBER: DO NOT YELL! (i.e., use all caps).

5. Back it up! While appreciated, unless requested, discussion boards are not the place for personal opinion. You must first qualify your argument with theory and research. Using examples are critical but the examples must be evidence-based and therefore should have a citation (if from outside the text).

6. Do not copy more than 2-3 sentences from the text. We are interested in your interpretation, not the books!

7. You want to write a first post that expands the conversation. Do not just agree or disagree. All posts and responses should be meaningful.

8. Ask questions if you are confused. Especially in responses, questions help other students to formulate replies.

9. Do not over-post just to post. We do not want to impose a length requirement - it is more about substance than quantity. However, each question should have a response that is from 1-3 paragraphs and each paragraph should have 4-8 sentences. Make sure if you use bullets to use them effectively and sparingly.

10. Impress us with your academic curiosity! Look for sources outside the text to strengthen your posts, responses, and replies.

Source: Developed by the Business Administration and Accounting faculty at Saint Michael's College

Integrating AWS Cloud Practitioner Certification into a Systems Administration Course

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Abstract

Cloud computing has grown to become an integral part of information technology (IT) infrastructure. Organizations are increasingly utilizing cloud services to deliver a variety of applications and services in conjunction with their on-premise data center environments. As such, students pursuing careers in information systems and computing need to add cloud concepts and skills to their "tool belts" to meet the demands of employers. Amazon Web Services (AWS) has the largest market share of cloud providers. This paper reports on a systems administration course at a private liberal arts institution that was re-tooled to integrate cloud computing fundamentals using AWS as a platform for hands-on labs. Cloud computing concepts paralleled content for the AWS Cloud Practitioner Certification Exam, which students took at the end of the course. The course provided necessary skills for students in their development as information systems (IS) professionals, as well as important lessons for IS and computing educators as they consider how to incorporate cloud computing skills into their curricula.

Keywords: cloud, computing education, certification, pedagogy, amazon web service, AWS

1. INTRODUCTION

The information technology (IT) industry has seen considerable growth in the use of cloud-enabled services, or those applications and services that are not within the confines of the traditional on-premise data center. Organizations recognize the advantages of having a flexible architecture that allows them to scale up or down as needed, to pay for compute, memory, and storage as a utility, and to provide for business continuity and disaster recovery in the event of service disruption. According to a white paper from IDC, 85% of enterprises will incorporate some combination of public, private, community, or hosted clouds into their environment (Anderson, 2017). The biggest players in the cloud space include Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP). Among these three, AWS has become the leader based on market share (Richter, 2021). AWS provides a complete suite of tools to launch server and serverless compute resources, file and blob storage systems, and fully managed databases, in addition to emerging technologies like artificial intelligence, quantum computing, and the Internet of Things (IoT).

A faculty member from the IS department within the business school collaborated with a recent alumni and systems analyst to redesign a systems administration course to focus on

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learning outcomes around platform-agnostic cloud computing concepts, build hands-on skills related to cloud, and to incorporate an industry recognized certification exam. The redesign of the course prioritized teaching students cloud concepts with a vendor-agnostic approach. However, learning about cloud computing is only one part of the equation. Students are more prepared for their careers when they have an opportunity to hone their craft in an applied fashion and receive validation from third-party stakeholders (Podeschi, 2016). Using this approach, the course incorporated several hands-on labs using AWS labs and tutorials. The course culminated with students taking the AWS Cloud Practitioner Certification (CLF-C01) exam.

This work builds upon previous research by Woods (2018), where cloud skills were successfully built into an introductory IT course. Specifically, this paper incorporates similar lab assignments alongside cloud concepts with the addition of the AWS Cloud Practitioner Certification exam. This paper first reviews the available literature related to the growth and use of cloud providers across the market in addition to previous research done on integrating cloud computing into the classroom. Course design is then outlined along with the results of a student questionnaire, summaries from lab assessment rubrics and student feedback from reflections, and results of the AWS Cloud Practitioner Certification exam. The paper concludes with a discussion on considerations for future courses and how the course can be improved upon. This research focuses on the design and implementation of the first iteration of incorporating cloud technology into the IS curriculum of a private 4-year university. The lessons learned in this class will serve as a guide for other classes within the major, and to other educators looking to enrich their courses. This work is important to information systems and computing educators so they can continue to evolve their respective curricula to meet the expectations of the industry.

2. REVIEW OF LITERATURE

The idea of cloud computing is not a new concept. Since the 1990s, users have been accessing computing resources that are not located on-premises, or within the walls of the organization. Consumers have also been accustomed to using Software-as-a-Service (SaaS) platforms for email through providers such as Gmail. To the layperson, cloud computing is simply the use of computing resources on another computer. However, the term "cloud computing" did not enter the commercial arena until 2006 when Amazon launched its Elastic Compute Cloud (EC2) service. These services transformed computing into a utility where companies could lease processing power, memory, and storage on a monthly basis (Erl, Mahmood, & Puttini, 2013, p. 27). Cloud computing as an IT strategy is a stark contrast from the traditional data centers located within the walls of an organization's corporate headquarters.

Organizations are making the case for shifting their IT services from on-premises (also known as private cloud) to hybrid or public cloud infrastructure. From a financial perspective, capital expenditures and depreciating assets are shifted to expense items on the balance sheet and income statement. Cloud computing offers scalability for organizations to be able to add compute, memory, and storage almost instantly. Much of this advancement is driven by virtualization technology and the ability to automate the provisioning of computing resources. In addition, cloud computing offers resiliency and ensures business continuity by using replication across geographically disparate data centers. (Erl, Mahmood, & Puttini, 2013, p. 28-30). These capabilities have allowed organizations to shorten the software development life cycle and increase service uptime.

Cloud computing can be broken up into three main delivery models: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS). SaaS typically only allows access to the front-end user interface, often through a web client. Application updates are applied by the vendor, and the customer has controlled choices regarding configuration settings. Products like Salesforce, Slack, and Gmail are examples of SaaS. PaaS allows some administrative control over IT resources. For example, the server operating system and established software packages may be pre-installed for the user to customize and configure. Some web hosting providers fit into this category. IaaS allows full administrative access to the virtualized infrastructure. The cloud vendor provides access to network, server space, and tools for provisioning virtual machines, configuring network, security, and applications. Vendors like AWS, Google Cloud, and Microsoft Azure are the three largest IaaS and PaaS providers in this space with a combined 61% of market share as of the end of 2020 as seen in Figure 1 (Richter, 2021).

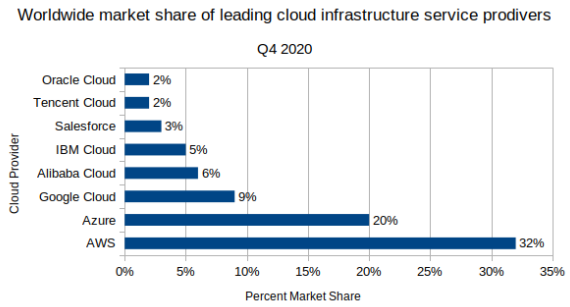

Figure 1: Cloud Market Share (Richter, 2021)

Employer Needs

With the ever-increasing push to move technology to the cloud, organizations are quickly realizing the need for cloud engineering skill sets. The Global Knowledge IT Skills and Salary Survey is an industry examination of skill needs and salary potentials for those skill sets formed from responses of IT professionals around the world. According to the 2020 report based on this survey, which produced 9,505 responses, cloud computing is the second most challenging area for organizations to find talent and the second highest invested skill area, only behind cybersecurity (Global Knowledge, 2020).

As the need for these specialized skill sets becomes apparent, talent acquisition strategies are relying more on industry credentials to quickly identify ideal candidates. Platforms like LinkedIn and vendor specific job boards, where certifications become gatekeepers for ranking high in search algorithms, have also largely contributed to the need for industry credentials. Even IT hiring-managers who are focused on "relevant skills" for a job say that certifications can serve as a distinguishing factor and pave the way for higher paying jobs and promotional opportunities (Global Knowledge, 2020). Research conducted by Gomillion (2017) concluded that while it was difficult to ascertain the value of one certification over another, obtaining an industry-recognized certification prior to graduation signaled the ability of a student to continue learning outside of class.

Furthermore, employers are looking for students who have real-world experience that extends beyond the typical classroom (Chuang & Chen, 2013). IS educators are continually looking for ways for students to build their resumé while they are pursuing their respective majors. This increases their marketability while applying for internships and pursuing full-time positions as students get closer to graduation. Several examples exist of previous research by IS educators espousing the success and value of integrating real-world projects into IS courses (Abrahams, 2010; Podeschi, 2016; Saulnier, 2005; Vaz & Quinn, 2014). These examples mostly manifest themselves as client consulting projects or assistance with not-for-profit organizations as service-learning opportunities. One unique way of identifying "resumé building" activities for students is through a broader concept using a third-party stakeholder. In the example provided by Podeschi (2016), a third-party stakeholder such as a business, panel of experts, or client evaluates the students' work rather than the professor, known as performance learning. In the case of passing a technical certification, that organization or certifying body is attesting to the students' knowledge in a particular domain.

Curricular Usage of Cloud

Examples of incorporating cloud concepts into higher education curriculum exist at least as far back as 2011, where Wang et al. (2011) explored it from a system administration perspective using an open-source stack to develop a private cloud. Chen et al. (2012) looked at incorporating public cloud services from Azure and AWS into separate data analysis and web development courses as short topics within the overall courses.

Lawler (2011) draws a strong connection between the IS 2009 Curriculum Model and cloud computing as it is transforming organizations and how they deliver IT services. Furthermore, he argues that cloud computing should be introduced earlier in the curriculum. One such implementation was done by Woods (2018) where AWS was utilized in an introductory IT course for students to deploy Python code and experiment with Linux. Students in this particular study found value in having hands-on experience with AWS and understanding how the infrastructure worked behind-the-scenes (Woods, 2018).

More recently, Palmer and Kim from Ovum Consulting (2019) analyzed the AWS usage of Arizona State University, Notre Dame and University of Queensland, both in their curriculum and as the infrastructure platform for the universities. Most of the research centered around how quickly universities can innovate in their IT curricula by leverage cloud platforms. Ovum concluded that university IT organizations "will be hard-pressed to support the institution through change" without the adoption of cloud platforms, due to the pace of technical innovation and the sheer variety of tools being leveraged in

the industry. Furthermore, they conclude cloud platforms can improve cost effectiveness of IT related degree programs, enable more innovation in curricula, and better prepare students for careers of the future (2019).

While some universities may have the resources and infrastructure to build out their own private cloud with IT resources for student work in IS/IT courses, not all institutions have the capital to stand up and maintain their own data centers. Whether students need server space for web applications, database design and querying, or general computation, the costs incurred in both time and money can be difficult for smaller institutions to manage. Cloud technologies can enable resource-strapped programs to leverage in-demand technologies (Mew, 2016).

Given the body of literature from both peer-reviewed and industry sources, there is a baseline case that the growing use of cloud technologies in industry is a necessary element in IS/IT curricula for students to remain relevant in their skill development for marketability as IS/IT professionals. Previous research also supports the conclusion that integrating cloud into higher education curriculum is key to maintaining a relevant and forward-thinking program while also shifting the burden of course technologies away from on-premises data centers. Given the prominence of current and future cloud usage, this research strives to address ways in which cloud computing can be effectively incorporated into computing curricula.

3. METHODOLOGY

Cloud Platform Selection

While there are several vendors in the cloud computing space, AWS was chosen for its free cost to students, its robust educational platform, its accessible entry-level certification, and its market share. According to Gartner (2020), AWS is considered to be the highest rated in terms of ability to execute and completeness of vision using their patented Magic Quadrant analysis. In addition, others have documented success with using AWS in the classroom based on previous studies (Wang et al., 2011; Chen et al., 2012; Woods, 2018). In a multi-year study completed by IT professionals related to the IT/IS knowledge and skills in demand by employers, the trends were leaning toward demand in cloud skills as well as the rising stature of AWS. The results indicate a shift away from Google to AWS and Azure compared to prior results, although respondents were mixed between the importance of cloud technologies growing or remaining the same (Janicki & Cummings, 2020).

Course Design

This Systems Administration course was designed to incorporate both industry and academic perspectives provided by the combined efforts of the information systems professor along with an industry practitioner. The learning objectives for the course, while broad, can be distilled down to two main pedagogical goals: provide the students with a fundamental and provider-agnostic understanding of cloud concepts and technology, and prepare the students for careers in technology through the completion of an industry recognized certification. Overarching concepts are going to be slower to change than a specific vendor or software platform, which will serve the students better over time.

In order to accomplish the first goal of the course, a provider-agnostic text by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood: "Cloud Computing: Concepts, Technology & Architecture" (2013) was utilized. This text focused on common technology that is leveraged across public, private and hybrid cloud platforms, and the underlying systems that power those platforms. Having been written in 2013, there were aspects to the textbook that have since become less relevant than when originally written. Specifically, there was a great deal of focus on how to build and manage a cloud platform versus how to leverage an existing cloud provider like Amazon Web Services in efficient and scalable ways. To address some of those shortcomings, external whitepapers and the industry perspective were provided to help contextualize the consumer interaction with a cloud platform. In surveying leading textbook publishers, the majority of titles were either vendor-specific or focused on a sub-category within cloud such as security or governance with few options left for a book that focused on cloud fundamentals.

The course was taught over sixteen weeks, with the first twelve being focused primarily on content delivery, and the last four a mixture of final project and preparation for the certification exam. To ensure the class maintained a provider-agnostic focus while still adequately preparing the students for the exam, the course was designed to follow the text and then the AWS specific skills and exam topics were subsequently mapped to each chapter (see Figure 2 in Appendix A). The core content centered around cloud concepts and models, cloud security, infrastructure, monitoring, management, delivery models, cost

metrics, and pricing models. These overarching concepts were presented and then interleaved with hands-on opportunities in AWS such as deploying Windows and Linux instances, configuring identity management, creating and managing a cloud database, and building a budget for a cloud deployment. A course outline can be found below in Table 1.

Systems Administration Course Outline	
Week 1	Intro to System Administration AWS Introduction
Week 2	Understanding Cloud Computing Virtualization and Linux Review
Week 3	Fundamental Cloud Concepts and Models
Week 4	Containers/Serverless Building Container Services using AWS
Week 5	Fundamentals of Cloud Security
Week 6	Cloud Infrastructure Mechanisms
Week 7	Monitoring and Alerting Business Continuity
Week 8	Cloud Management
Week 9	Configuration Management Cloud Security Mechanisms
Week 10	Identity Management Cloud Delivery Model Considerations
Week 11	Database Management in the Cloud
Week 12	Cost Metrics and Pricing Models
Week 13	Review Key Concepts Final Project Work
Week 14	Prepare for AWS Certification Exam
Week 15	AWS Practice Exam and Final Project Work
Week 16	AWS Cloud Practitioner Exam Final Project

Table 1: Systems Administration Course Outline

Lab Exercises in AWS

A key lesson learned from the course was how to successfully manage the chosen cloud platform in a way that allows the students broad access to explore the provided services, but still maintained safeguards against surprise costs associated with the use of those services. AWS, along with many of the other cloud vendors, allows customers to set up accounts for free and access a range of services without incurring costs under a "free tier". This tier includes the use of "micro" sized VMs (1 virtual CPU core and 1 GB of RAM), as well as small volumes of other services such as object storage and managed databases. To fully leverage these offerings, students in the class were given instructions on setting up their own AWS account using their own contact and payment information. That account gave students their own cloud environment, with access to all the services that an enterprise IT organization would have.

Course material and quizzes were supplemented with hands-on work in the form of lab exercises to help bring the concepts to life. These labs fell into two general categories: prescriptive labs where students were given step-by-step directions and more abstract case studies where the students were given real world challenges to solve with limited direction. Throughout the course, students created Linux and Windows virtual machines (VM), learned how to use S3 storage in conjunction with a static website, and built and performed queries on a MySQL database using Amazon RDS. In addition, students analyzed a business case to identify architecture requirements and provide cost estimates as well develop an organizational identity and access management structure.

The midterm and final projects combined aspects of both types of labs. For the midterm, students were given the challenge to combine concepts from previous labs, such as VM creation and networking in order to build a self-hosted WordPress website on EC2. For the final project, students were given a choice of four options, each of which focused on slightly different concepts so students could tailor their choice to their personal interests. Students could choose between automating the deployment of Minecraft servers, creating a continuous delivery pipeline using Amazon Elastic Beanstalk and Amazon's Code(*) suite of services, deploying a LAMP (Linux, Apache, MySQL, PHP) stack web application, or automating application programming interface (API) calls to retrieve weather data. Most students elected to build a LAMP stack application, likely due to the resemblance to the skills developed in the midterm.

Each lab was assessed using the rubric as seen in Appendix A, Figure 3. Students were required to document their work using technical language and screen shots such that another person could follow their work to reproduce the same results. Their work was also assessed for their ability to produce a working environment, that steps were executed properly, and that testing was done to ensure that services were working properly. In addition, students were asked to reflect on the lab and draw connections to course material from this

class and others, how organizations could benefit from the AWS cloud service, and to connect the lab to their desired careers.

Certification Exam

The AWS Certified Cloud Practitioner exam was intentionally built into this course as a way for students to build their resumé while still in school to increase their marketability as IS/IT professionals. With AWS controlling approximately 32% of the global cloud computing market as of 2020 (Richter, 2021), the AWS Cloud Practitioner has become the de facto credential for IT professionals working in a cloud environment. The AWS Certified Cloud Practitioner examination focuses on four main topics: cloud concepts, security and compliance, [core] technology, and billing and pricing (Amazon Web Services [AWS], n.d.). Course topics can be seen mapped to AWS Cloud Practitioner domain areas in Appendix A, Figure 2.

The cost of the exam as of October 2020 was $100 USD (Amazon Web Services, n.d.). For this pilot, a corporate sponsor and strong institutional supporter funded the cost of exams for every student in the course regardless of whether they passed the exam. While the corporate funding lowered the barriers to entry for students, there is anecdotal evidence from course feedback surveys that the price is within most students' willingness to pay for the opportunity to earn an industry credential. Passing the AWS Cloud Practitioner Exam was not weighted in such a way that it would prevent a student from passing the course (15% of total grade). While the instructors' combined experiences and Gomillion's (2017) research both supported the importance of obtaining the certification, the goal was still to allow students to balance their time appropriately between focusing on foundational concepts, hands-on lab exercises, and preparing for the exam.

4. RESULTS

Because of the small class size, drawing statistical conclusions was not possible. However, comments from the pre-course survey, student reflections, lab assessment data, and exam scores provided insight into the outcomes of the course. This section will highlight these specific areas.

Pre-course Survey

At the beginning of the course, students were given a survey to gauge their level of comfort with the curriculum and their level of interest in different aspects of the course. Students generally felt excited about the course, though few of them claimed any experience with cloud technology outside of SaaS solutions like Google Drive or Office 365. Another common sentiment expressed by the students was anticipation for the certification exam. All the students responded that they found the incorporation of the AWS Cloud Practitioner certification very valuable, and while the cost of the exam was being covered by a corporate sponsor, half responded that they would take the exam even if they had to cover the costs themselves.

Lab Assessment

Throughout the ten labs in the course, several trends were observed. Generally, students excelled in the guided work. More often than not, all the students successfully completed the steps outlined in the lab and could troubleshoot their way through any errors they encountered with minimal guidance from the instructors. Where students tended to fall short was in the technical documentation, and reflection components of the labs. For many of the students, the documentation served only to prove that they completed the labs but did not contain enough detail to have guided someone else through the same process. Similarly, in the reflections, several students simply summarized their work and the comprehension of the base learning objective without synthesizing into how that skill could apply to real world scenarios or connecting it with topics covered in other classes. One exception to this trend was in the final reflection that accompanied the final project. This reflection counted for a more substantial part of the overall project grade, and it asked the students to reflect on their learning throughout the entire class instead of the specific project.

When reflecting over the class as a whole, students were able to articulate many of the outcomes the class had been designed to achieve. One student reflected, "It [the class] taught me how to navigate understanding and conversation about different aspects of IT." Naturally, technical issues will occur, and students recognized that "when working with technical platforms to complete a certain goal or problem, things will often not go as planned or not work the first time." While not cloud specific, the labs did help students understand the value of learning general troubleshooting and problem-solving skills. Most importantly, students came away understanding the value cloud computing has in the future of IT architecture. One student remarked that "...how a company, big or small, can utilize the cloud, and how relevant the cloud is." Likewise, in general,

another student recognized that "Truly cloud computing resonates with me because I know that I use the cloud every day."

Certification Exam Results

Of the five students who took the certification exam, three passed and earned the AWS Certified Cloud Practitioner credential. An exam is considered passing with a score of 700 out of 1,000 points. Exam scores in the class ranged from 541 to 905 with a median of 760 and an average score of 718.2. After comparing course grade data with AWS exam results, those who passed the exam also performed best in the class in terms of their final grade. These students typically prepared their assignments at a level that demonstrated understanding of the material, were able to connect the content to other topics they had learned and took outside opportunities like webinars and free training to learn more about AWS. As a practitioner certification, the CLF-C01 is not designed to demonstrate an in-depth technical knowledge of the AWS suite of tools, but rather a general understanding of cloud principles regardless of job role (Amazon Web Services, n.d.). As such, having a student feel prepared to handle conversations involving cloud computing is an ideal outcome for the class.

5. DISCUSSION AND CONCLUSIONS

This paper outlines the design and implementation of the first iteration of incorporating cloud technology into the IS curriculum of a private 4-year university. The lessons learned in this class will serve as a guide for other classes within the major, and to other educators looking to enrich their courses.

Throughout the course, a major struggle was balancing the desire to teach topics in a flexible, provider agnostic way, and the need to prepare students for the topics and specific services covered in the CLF-C01 exam. For the reasons mentioned previously in the paper, the benefits of teaching AWS seemed to outweigh the risks, but in the final reflection some students did express a desire for a wider breadth of exposure to other providers. Specifically, one student stated: "One thing that I wish would have been incorporated in this class would be discussing the advantages and disadvantages of GCP and Azure compared to AWS". While finding instructors or texts that can effectively speak to all 3 of the major cloud providers equally is incredibly challenging, at least providing a solid foundation of the different platforms could better set students up for real-world hybrid-cloud scenarios.

The course served students who had varying career aspirations. Some students taking the course were pursuing developer positions while others were more interested in becoming business analysts. For example, one student commented in a reflection question that "while not entirely sure that my career path will directly involve those AWS services, I think knowing more about the concepts behind those services and how they can be utilized will make me more knowledgeable and well-rounded when working as a developer."

It is difficult to expect every institution to have access to industry professionals who can bring in-depth knowledge of cloud computing to the classroom. For faculty looking to implement cloud computing into their curriculum without previous cloud experience, it is highly recommended they find a way to familiarize themselves with the various platforms and services available. Each major cloud provider, Amazon, Google and Microsoft, has their own foundational certifications and corresponding free online training, similar to the CLF-C01 AWS Cloud Practitioner Exam leveraged in this course. Studying for and achieving one of these certifications is an effective way to properly prepare for and have a level of understanding of cloud computing to successfully teach a class like this.

After further use of AWS in subsequent classes, AWS's educational offering, *AWS Educate*, proved to be a platform with useful additional classroom management features. In *AWS Educate,* students receive $50 in AWS credits to use across their entire portfolio of products and faculty receive $200 in credits to use for shared environments and testing. Faculty can also manage classroom enrollments and get some insight into students' environments. As of December 2021, AWS is transitioning their *AWS Educate* platform to their new *AWS Academy* platform. At the time of this research, not enough information is available to share the differences between *AWS Educate* and *AWS Academy.*

Another important reflection is the limited visibility and higher risk posed by students using individual AWS accounts. While there was little overhead in costs of having each student have their own AWS accounts, it also meant the instructors did not have access to view the services they were spinning up. Due to this limitation, grading relied heavily on the student's provided documentation of their steps. It also meant troubleshooting issues for the students required one-on-one meetings so they could

share their screens. An alternative strategy that has been leveraged in subsequent courses is to manage a centralized AWS account that all students log in to. This method provides increased visibility at the expense of extra management overhead by the instructor.

This course redesign was an important step in identifying ways to better incorporate cloud computing into the IS curriculum. Since the course was offered, some lab exercises have been repurposed for use in pre-requisite courses like Foundations of Information Systems and IT Infrastructure. Specifically, the sections involving server virtualization and cloud storage have worked well in the lower-level IT Infrastructure course. Putting those elements into supporting courses provides the opportunity to move to more sophisticated lab exercises focusing on topics like containerization and infrastructure as code in the next iteration of this systems administration course. The future goal would be to offer the course again connected to the AWS Cloud Practitioner Certification to not only benefit students, but to also gather more data on student outcomes in-class and as alumni.

Naturally, additional research is needed to better assess the most effective methods for incorporating cloud computing into the curriculum, but these lessons can provide guidance to other educators wishing to pursue teaching cloud concepts. It is the authors' hope that future courses will garner higher enrollment and allow for continued research and a larger sample of student data from which to validate these initial results.

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Appendix A

Systems Administration Course Topics Mapped to AWS Cloud Practioner Domain Areas			
Course Topics	AWS Cloud Practioner Domain Areas		
	Domain 1: Cloud Concepts		26%
History of Enterprise Data Operations		1.1 Define AWS cloud and it's value proposition	
Review Infrastructure and Virtualization		1.2 Identify aspects of AWS Cloud economics	
Understanding Cloud Computing		1.3 List different cloud architecture design principles	
	Domain 2: Security and Compliance		25%
Cloud Security Fundamentals		2.1 Define the AWS shared responsibility model	
Service Quality Metrics and SLAs		2.2 Define AWS Cloud security and compliance concepts	
Cloud Security and Access Management		2.3 Identify AWS access management capabilities	
Monitoring and Alerting		2.4 Identify resources for security support	
	Domain 3: Technology		33%
Cloud Compute: Serverless and Containers		3.1 Define methods of deploying and operating in the AWS Cloud	
AWS Global Infrastructure		3.3 Define the AWS global infrastructure	
Cloud Storage and Databases		3.3 identify the core AWS services	
Cloud Infrastructure Management & Automation		3.4 Identify resources for technology support	
	Domain 4: Billing and Pricing		13%
Cloud Delivery Model Considerations		4.1 Compare and contrast the various pricing models for AWS	
Cost Metrics and Pricing Models		4.2 Recognize the various account structures in relation to AWS billing and pricing	
		4.3 Identify resources available for billing support	

Figure 2. Course Topics Mapped to AWS Cloud Practitioner Domain Areas

	Mastered 4	Proficient 3	Developing 2	Beginning 1
Start Service Successfully (10%)	All Services in the lab started correctly without errors	Most services in the lab started correctly without errors or contained minor errors	Some services in the lab started correctly without errors or contained errors that prevented them from starting	Few services in the lab started or contained major errors
Execution (25%)	Lab steps have been executed fully and according to directions paying attention to detail	Lab steps have been executed mostly and according to most of the lab instructions	Some lab steps have been executed, some steps not in the correct order, or have been left out	Little attempt was made to complete the lab steps according to the instructions
Testing (20%)	Project has been fully tested, services are verified operational, with exceptions noted in detail	Project has been mostly tested, services are verified operational, exceptions may not be detailed.	Project has been partially tested, services may not have been verified operational, exceptions may not be noted	No attempt to test or note any exceptions
Documentation (25%)	Documentation is fully complete, accurate, professional, and appropriate to target audience(s)	Documentation is mostly complete or mostly professional, highly accurate with only minimal divergence in audience appropriateness	Documentation is well attempted though missing portions, has more than minor inaccuracies, or is not appropriately framed for the target audience	Documentation is insufficient or missing, has major errors, or is not created to the appropriate level
Reflection and Application (20%)	Student reflected on the lab in a way that demonstrates a connection to the course material, use case, or real life application citing multiple examples	Student reflected on the lab in a way that demonstrates a connection to the course material, use case, or real life application citing at least one example	Student partially reflected on the lab that connected to the course material, but lacked depth or detail	Student made an attempt to reflect on the lab, but was insufficient

Figure 3. AWS Lab Assessment Rubric

Enhancing Student Career Readiness through Skills Infusion

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Abstract

The rising cost of higher education has led parents, employers, and politicians to question the need for a college degree. Skills Infusion is a professional development program in which faculty review a course they teach to identify the career readiness competencies defined by the National Association of Colleges and Employers (NACE). The NACE competencies are skills that are expected by employers across all sectors of the economy. In addition to describing the Skills Infusion program, a description of how an information technology undergraduate program is expanding on the program to incorporate skills mapping to provide further evidence of accountability in higher education.

Keywords: Career Readiness, Skills Mapping, Curriculum Mapping, Higher Education, Accountability

1. INTRODUCTION

The expectations that society places on higher education are evolving. It can be argued that the purpose of higher education has been to challenge one's beliefs (Busteed, 2019) through the quest for knowledge. This lends credence to college and university mission statements that talk about global citizens and lifelong learning (Pasquerella, 2020). Lately, the question has arisen as to whether these continue to be the only expected outcomes of higher education.

The rising cost of higher education (Hanson, 2021) has prompted politicians and parents to question whether the outcomes of obtaining a degree justify the costs (Kelchen, 2018). Effectively, higher education is being held accountable. A shift has occurred in which employability is an additional outcome expected of higher education (Sin, Tavares, & Amaral, 2019). In the Fall semester of 2019, Ball State University (2021) introduced its Skills Infusion Program as a strategy to enhance job skills that will transfer to the workforce across academic disciplines. The remainder of this manuscript will expand on the issue of higher education accountability and the Skills Infusion Program.

2. ACCOUNTABILITY IN HIGHER EDUCATION

As the cost of attending college continues to rise (Carnevale, 2020), the need for higher education is being questioned (Carapezza, 2021; Quiroz-Gutierrez, 2021). For students not receiving a full

scholarship, the rising cost of higher education presents a challenge and a debate to many, not to mention the time invested in it. While there are other benefits presented with the attainment of a college degree, the potential to earn more than is likely attainable without a degree is the main reason.

According to the U.S. Bureau of Labor Statistics (2021), education attainment and earning potential are directly related. Jobs that require higher-level education and higher skills get paid very high wages, jobs that require little to no education and low-level skills get paid lower wages. Unemployment rates are significantly lower for college-educated personnel, whereas lower educated personnel face very high-level unemployment rates. Similar to the 2009 inflation crisis, the COVID-19 pandemic followed the same trend mentioned above across multiple industries. Earnings, bonuses, and other benefits increase significantly for workers with college degrees compared to those without.

The government and other stakeholders that invest in higher education have increased expectations of accountability (Zumeta, 2011). These stakeholders are asking institutions of higher education to provide evidence that students are learning marketable skills that lead to high-paying jobs.

3. NATIONAL ASSOCIATION OF COLLEGES AND EMPLOYERS (NACE)

NACE was established in 1956, connecting over 9000 college service professionals, 3200 universities, and 300 business solution providers. NACE is a major source of information on employment opportunities for college students.
NACE (2021) identified eight career readiness competencies that are essential for college graduates to secure high-paying jobs. These competencies include career and self-development, leadership, communication, professionalism, critical thinking, teamwork, equity and inclusion, and technology in the workplace.

- Career and Self-Development: Continuous professional and self-development abilities include awareness of their strengths and weaknesses, building relationships, and progress in job growth.
- Communication: Includes strong verbal, written capabilities, and communicates in a clear precise manner through various media.
- Critical Thinking: Making decisions through reasoning and judgment without bias.
- Equity and Inclusion: Engage and include people from local and global cultures, awareness racial policies and laws.
- Leadership: Inspiring and motivating self and teams towards organization goals.
- Professionalism: Integrity and accountability towards self, others, and organization.
- Teamwork: Working in a team to attain common goals and objectives.
- Technology: Embracing technology, and constantly updating themselves with newer technologies, knowledge of technology usage policy.

NACE (2021) asserts that when higher education incorporates these core competencies, students are better positioned to successfully start their careers, independent of academic discipline. Career readiness includes the essential skills and competencies that students will need to enter the job force and build on their careers (Department of Education, 2016; Zook, 2018). The issue of competency has more recently been identified as a priority with ACM and IEEE in their joint Computing Curriculum 2020 Task Force report (2020). The report further defines competency to be the summative outcome of knowledge, skills, and disposition. It is commonly accepted that higher education is a purveyor of knowledge. To be competent, the task force is stating that students must also have the ability to go from theory to practice by applying work-related skills and to have the appropriate individual character to appropriately and professionally carry out those skills.

4. CURRICULUM MAPPING

Curriculum mapping refers to the process of identifying what is being taught across the curriculum of an academic program (Uchiyama & Radin, 2008). The process starts with assessing what is being done within individual courses. These individual assessments are aggregated to map out where topics are being taught throughout the curriculum. This comprehensive mapping can then be used to identify core competencies, skills gaps, or areas of overlap within the curriculum.

While primarily used for program review associated with both internal and accreditation program assessments, curriculum mapping can also provide evidence of accountability in higher education. A curriculum map and student artifacts can be shared with parents and politicians to exemplify how a program is fostering the skills that will enhance student employability.

5. SKILLS INFUSION PROGRAM

The Skills Infusion Program is a professional development experience that takes place for one semester and focuses on reviewing course syllabi, mapping course outcomes to the NACE career readiness skills, and reflecting this on syllabi with input from the Career Center and an Indiana employer/alumni partner. The goals are to help students better articulate transferable skills learned in concert with course content and to provide a gap analysis tool that students can use to reflect on skills not yet practiced or learned. The expectation is that faculty are already incorporating aspects of the NACE competencies in their courses. The Skills Infusion Program is an exercise to clearly identify to students the career competencies they are developing that may not be obvious in the official course description. It is not prescribed that faculty must incorporate all of the NACE competencies into their course design. Instead, they are encouraged to consider ways how the unaddressed competencies could be integrated into the course.

Each faculty participant is tasked to select one of their existing courses for the duration of the workshop. At the end of the workshop, the course (with the newly infused learning outcomes) will be presented to the group.

Faculty participants are tasked with reviewing the NACE competencies and mapping them to the assignments in their course. This is a preliminary exercise that serves to prime the actual mapping of skills that take place during the program.

The first workshop begins with introductions and goal setting for the program. Breakout sessions are conducted with faculty participants and a faculty mentor. The Career Center selects mentors from among the faculty members who were exemplary during previous sessions of the Skills Infusion Program. The mentor guides the first iteration of the NACE mapping process, addressing questions by the participants. The intent is for faculty to reflect upon how their course design addresses the eight Career Readiness competencies. For each assignment, faculty will need to identify the competencies that are being addressed and reinforced. These should then be incorporated into the syllabus as part of the student learning outcomes. After the first workshop, the entire group reconvenes and presents their progress.

The second workshop is dedicated to introducing faculty to alumni and BSU Career Center personnel. These individuals serve to provide faculty with insight into the expectations of employers. Faculty share the competency mapping they identified for their course. Keeping in mind that the final outcome is to have a syllabus that shows students how the assignments translate into career readiness competencies, the alumni and Career Center personnel then provide the faculty with suggestions on how to improve and clarify the student learning outcomes.

The final workshop serves as a wrap-up. Faculty present their new syllabi with the NACE mapping embedded in the document. The faculty answer questions on how the mapping took place and the rationale behind the decisions. This final workshop concludes with an "ah-ha" session where faculty present their biggest takeaway from the program.

CT 211: System Administration Fundamentals

One of the authors of this article utilized the CT 211 course for the focus of the skills infusion workshop. The course is designed to introduce students to Windows Server systems administration. Topics covered in the course focus on enterprise technology solutions for organizations. Specific topics include service configuration (e.g., DNS, DHCP), high availability, and systems scalability. The course is quite technology-centric, and a required course for all CIT students.

CT 466: Capstone in Computer Technology

The second class revised through the Skills Infusion Program was the Capstone Course in Computer Technology. The class serves as the culminating course of the program. It is designed to foster a systems thinking approach to information technology infrastructure design and preparation for the transition from student to working professional. With the latter goal in mind, each assignment in the course was reviewed for the NACE skills that it fostered.

6. EXTENSION OF THE SKILLS INFUSION

The NACE competencies provide a good starting point to identify the transferable skills that are universal to jobs across disciplines. This was the extent of the expectations by the university for participation in the Skills Infusion Program. However, this seemed insufficient for an information technology program whose students will need to show that they have knowledge, skills, and abilities in specific technologies as they apply for internships and full-time employment.

In addition to the NACE competencies in the CT 466 capstone course, specific technology skills were mapped out for each of the course assignments. This skills mapping was based on the instructor's personal experience and interactions with employers. To provide context for what was done, an explanation of the term project is in order. The purpose of the degree in Computer and Information Technology is to prepare students to be the next generation of IT professionals. To reach this goal, students need to be able to integrate the diverse technologies required by employees across departments and job functions. The capstone course presents teams of students with a fictitious retail company for which they have to develop the technology infrastructure and systems required for the company to be operational. It may be unlikely that students will have the opportunity to build an organization from scratch; it provides them with an opportunity to develop a more comprehensive, systems approach to information technology. This fosters an understanding of the connections and interdependencies between the diverse technologies that are taught in previous classes.

The progression of the project contains the following stages:

1. Design and build a virtualized data center infrastructure
2. Design and build a network infrastructure
3. Install and configure core infrastructure services (e.g. DNS, DHCP, Active Directory, website)
4. Install and configure enterprise (e.g. email servers), departmental (e.g. human resource, accounting, finance, point-of-sale server), and individual software (e.g. office suite applications, email client, anti-virus, point-of-sale client).
5. Secure the previously listed components in this design.

So how does all of this relate to Skills Infusion and skills mapping? For each stage of the project, the specific skills and technologies that were required were identified. The data center infrastructure alone consisted of several technical skills. To build the skills mapping for the project, an engineering journal was used to document the skills used at each step in the process. Upon review of the engineering journal, the marketable skills were listed for each assignment throughout the project. The marketable skills were identified based upon reviews of job descriptions related to associated positions in information technology. Table 1 provides an abbreviated sample of the table that appears in the course syllabus. This skills mapping will provide students with a list of projects/assignments and the corresponding skills developed.

Assignment	Workplace Competencies	Technical Skills
Service Manager Initial Assessment	Critical Thinking / Problem Solving; Leadership; Written Communication	Technical lead on evaluating software alternatives. Comparative analysis of software to determine fit based on organizational needs. Reviewed installation requirements to identify hardware and dependencies.
Project Management Plan	Critical Thinking / Problem Solving; Teamwork / Collaboration; Written Communications; Digital Technology; Leadership; Career Management	Conducted work breakdown analysis for implementing the technology infrastructure in the area in which I was technical lead. Aggregated work breakdown analyses for each area to identify what could be done simultaneously versus sequentially. The team built a project plan using an online, collaborative project management service.

Table 1 - Sample of Competency Mapping

The purpose of the skills mapping is to provide students with a tool to assist them in building resumes and cover letters for internships and jobs that accurately reflect their skills development. A common refrain among students is, "What do I put in my resume?" Frequently, the answer is that students list the overarching topic for each of the classes they took. The result is a generic list of operating systems and applications.

It is recommended to students that they customize the content of a resume and cover letter to address the specific knowledge, skills, and abilities indicated in the job description and responsibilities (Doyle, 2021; Weickmann, 2021). Students do not typically have the relevant work experience to bolster that aspect of their resumes. Instead, students are encouraged to draw upon their roles in projects to highlight how they applied the skills that correlate with the internship or job to which they are applying. The skills mapping gives students an inventory of the specific technologies and skills that were associated with those assignments. Students can draw upon this to customize the education and/or skills sections of their resumes with activities that are relevant to the internship/job.

In addition to students, the skills mapping also addresses the concerns of other stakeholders. Students can show parents documentation of the marketable skills that were developed in the course. The skills information can also be used as evidence to politicians that student tuition results in gaining identified marketable skills that will positively impact student employability and career development.

7. STUDENT SURVEY

A typical collegiate course will present the student learning outcomes in its syllabus. These outcomes indicate what students will know or be able to do at the end of a course. These student learning outcomes are important for conveying the larger goals and objectives for the course. They do not, however, provide the granular identification of marketable skills offered through the skills mapping.

Of concern is whether students can independently identify the technology skills embedded in courses. A preliminary exercise was conducted with the students in CT 466. The project groups were asked to review their assignments to identify the NACE outcomes and technology skills that they thought the assignments developed. To help in this process, they were provided with the NACE career readiness outcomes and a discussion of marketable technology skills. The skills mapping conducted by the instructor was not provided to the students in advance of the assignment.

A review of the submissions yielded some interesting observations. The first observation is that students did not identify the technical skills with sufficient specificity. For example, an assignment required project groups to build a project plan using an online, collaborative project management tool that they were to use throughout the semester. Instead of stating the tools they used, such as Asana or Trello, students indicated that they used "project management software" or "online digital technologies". These generalizations were evidenced by most of the groups for all of the assignments. There are possible causes for this observation. It may have been a lack of clarity or misinterpretation of the instructions. It could also be as simple as a lack of motivation. The class was primarily enrolled with students in their last semester before graduation.

Another observation was that students were able to articulate how the assignments aligned with the NACE career readiness competencies. Students from each of the project groups were able to write action statements indicating how the assignments fostered specific NACE competencies.

8. WHERE DO WE GO FROM HERE?

The deep skills mapping was only conducted in the Spring 2021 capstone course. As a capstone course, the higher-order skills should be critical thinking, technology integration, and systems thinking.

The program intends to conduct NACE and technical skills mapping throughout the Computer and Information Technology degree's curriculum. Once the faculty have completed the skills mappings of their assigned classes, the collected data will facilitate three program initiatives.

Student marketable skills database

The priority of the skills mapping is to provide students with a comprehensive database of the marketable skills they should expect to develop in individual courses throughout the curriculum. Students will be provided a tool by which they can look up the classes they have taken and review what marketable skills they were to have acquired.

In light of the preliminary data suggesting that students have difficulty identifying the marketable skills in a given class, providing a database of marketable skills for the curriculum should provide multiple benefits to students. Students entering the Computer and Information Technology program do not always know what area of information technology they would like to pursue. Being able to review the marketable skills associated with courses in the curriculum will provide students with insight into the

responsibilities associated with the different technology areas. The extended set of marketable skills in the database will also have a broader selection of skills to choose from as students create customized cover letters and resumes for internship and job applications.

Curriculum mapping

Students will not be the only stakeholders to benefit from the marketable skills database. At the time of the Spring 2021 semester, curriculum mapping for the Computer and Information Technology program was based on the Student Learning Outcomes defined on the course master syllabi. This has provided a broad overview of the content throughout the program. The problem has been that the student learning outcomes are written to address the larger concepts or topics. When working with information technology the details are critical in determining where there are skills gaps. For example, the student learning outcome may indicate that a course will "develop a complex Active Directory domains design that meets organizational needs". At a broader, conceptual level, the statement conveys the intended outcome. What is not provided are the technical details. To effectively manage the overall curriculum in an information technology degree, the program director needs to know the version of the operating systems being used; in which classes are they being taught; are the Active Directory designs incorporating both Organizational Units and subdomains?

This is not a criticism of student learning outcomes. They are not intended to provide granular detail about the content of the course. Highlighting the limitation of the student learning outcomes simply reinforces the programmatic value of the skills mapping. The skills mapping will answer the questions presented about the mentioned student learning outcome about Active Directory. Being able to analyze the details of the content across courses will help identify the gaps in skills desired by employers and those that are taught in the curriculum.

Accreditation

The process of skills mapping will also support assessment associated with accreditation. The U.S. Department of Education (2021, par. 1) states, "The goal of accreditation is to ensure that institutions of higher education meet acceptable levels of quality". The accrediting bodies for respective academic disciplines typically present broad learning objectives that degree programs in their field of study should accomplish. It is up to the academic program to reflect those student learning outcomes in their programmatic goals and objectives. The academic programs are then required to conduct periodic assessments to provide evidence that it is accomplishing the learning objectives set forth by the accrediting body.

The purpose of assessment is to determine whether an academic program is effectively meeting its stated goals and objectives. The skills mapping can aid in identifying key points across the curriculum that will provide the most relevant assessment data. If the accrediting body requires specific skills or competencies, the skills map will identify the courses where assessment should be done. It may be that the program administrator wants to show the progression of competency in a skill across the curriculum. The skills map will pinpoint where assessment can be conducted to gather data on student competency for that skill.

9. CONCLUSION

The Skills Infusion Program was designed to encourage instructors to identify how their courses will foster the career readiness competencies identified by NACE. The competencies, which include critical thinking/ problem solving; oral/written communications; teamwork/collaboration; digital technology (literacy); leadership; professionalism/work ethic; career management; and global/intercultural fluency, are relevant to all academic disciplines. Students are then able to use this information to highlight how they have developed these universal competencies as they apply for internships and jobs. The Computer and Information Technology program is taking this process a step further by also identifying the technical skills developed in its courses. The identification of competencies in specific technologies will benefit both students and administrators. It will provide all stakeholders with data to show that the program is effectively preparing students for their careers upon graduating.

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How the COVID-19 Shutdown Impacted Student Grades at the Collegiate Level?

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Abstract

During the Spring 2020 semester, universities around the world were forced to make quick decisions and adjustments to their learning environments to offset the COVID-19 pandemic impacts. This swift conversion of face-to-face and hybrid courses to an online / remote learning environment left higher education institutions in disarray causing them to quickly execute a transition plan that had never been deemed necessary. While some faculty were pushed into a new and unfamiliar environment, students were left scrambling to acquire trainings and resources to help with their transition. This study analyzed the impact of training and resources provided to students / faculty and how they affected students' final grades. The researchers distributed a survey at two small mid-Atlantic universities with 139 respondents at the undergraduate and graduate levels. The results of the study were analyzed to understand the overall impact on students' final grades. The outcome of the study assessed this impact to identify gaps that should be considered to better support student learning.

Keywords: Covid 19, pandemic, remote learning, grading impact, online learning, faculty

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1. INTRODUCTION

Since March of 2020, everyone has had some daily impact related to the COVID-19 pandemic. These impacts include major disruptions in how one completes daily tasks, school, employment, and overall health. In the blink of an eye, first year students to graduating seniors were forced to change from sitting in the classroom to returning home and joining a virtual world. While this decision was not one that administrators in higher education would overturn, it is one that could ease the impact with a proper implementation plan.

As of July 2020, 98.6% of student learners were impacted by the pandemic spanning 200 countries and affecting 1.725 billion students in pre-primary to higher education (United Nations, 2020). To mitigate the risks associated with the modified instructional delivery due to the pandemic, universities had to equip their students and faculty with tools, training, and resources to help foster a better learning environment. While this was no easy task, it was an essential one that would otherwise compromise the success of our education and instructional delivery. Online coursework is very popular, and one often forgets that a substantial student base and faculty have remained committed to face-to-face instruction and have never endeavored into a virtual learning environment. This exploratory study will assess the impacts on students' final grades based upon trainings and resources that were made available to them by the university.

2. LITERATURE REVIEW

Garcia et.al. (2020) have a three-pronged plan for addressing the impacts of COVID-19 on education which they call the three R's: relief, recovery, and rebuilding. Relief provides schools the resources so that they can offer effective instruction and support. Recovery is investing to help students make up lost skills as school returns to normal operations. Rebuilding is redesigning the system to focus on skills development which ensures that all students have access to resources that will enhance learning and development.

The flexibility of E-Learning compared to face-to-face teaching has led to many students becoming "self-directed learners" (Keis, 2017). However, some studies have shown that a number of learners have difficulty in the area of self-discipline. There must be an ongoing interaction between students and instructors, along with a stated clarity of the requirements and goals of the learning process. (Dochery et.al., 2019) Research has shown that two-way feedback helps the student to stay connected and motivated. This interaction, along with social support is essential in the success of this type of modality (Bernard et.al. 2009). Social and collaborative learning allows students to work together and expand their knowledge in a collective forum.

For students to be successful with online learning both students and faculty must be proficient in their use of online learning tools. This of course assumes that both students and faculty have access to the appropriate technology and Internet. A critical aspect highlighted by Bettinger and Loeb (2017) is that online courses are difficult, especially for students that a not prepared.

Technology can have a downside as well and dependence on it to deliver critical services can lead to phenomena such as "Zoom fatigue" and sense of loss around deep personal connections which foster belonging (Ramachandran, 2021). At the same time, the rise of almost complete dependence on ICT to help foster connection and belonging has only highlighted disparities among students that college and university staff already knew existed. O'Brien (2020) speaks to the technological divides that "leave some of our most vulnerable students struggling with limited or no broadband access and/or without appropriate devices to engage in learning" (para. 7).

Aucejo et.al. (2020) conducted a study at Arizona State University during the pandemic and found that 13% of students delayed graduation, 11% of students withdrew from a class and 12% of students changed their major. The authors stated, "if students perceive a negative treatment effect of COVID-19 on the returns to a college degree, this belief will have an impact on their future human capital decisions (such as continuing with their education, choice of major, etc.)."

A study conducted by Rodriguez-Planas (2021) analyzed approximately 12,000 college students' academic records. The study compared low-income students to their higher-income peers. The results revealed that top-performing lower-income students had a decrease in grades by 5% and earned credits by 11% as compared to their higher-income peers. Recent studies (Aucejo et al. 2020; Rodriquez-Planas 2020) have found that lower-income college students were more likely to experience online learning challenges, considered dropping classes and delayed graduation as compared to their higher-income

peers. These percentages were derived from comparing the COVID-19 lockdown students to the previous three years of grades.

Engzell et.al. (2021) evaluated the effect of school closures as it related to school performance during the COVID-19 lockdown in the Netherlands. The results of their study revealed that their students had a 3% learning loss which is equivalent to one-fifth of the school year. Losses are up to 60% larger among students from less educated homes.

The effects of online schooling on student outcomes during the COVID-19 pandemic will take time to fully understand but early evidence is not reassuring. Backer-Hicks et.al, (2021) find that school-related Google searches rose at the beginning of the pandemic in wealthier areas as compared to searches in low-income areas. These Internet searches indicate an effort put forth to substitute for loss of in-person instruction (Hinrichs, 2021).

Research conducted by Bozkurt, et al. (2020) examined the impact of COVID-19 on education in 31 countries. The researchers highlighted major themes due to the interruption in education such as 1) the inequity of the digital divide, 2) the need for alternative assessment and evaluation methods for both synchronous and asynchronous learning, and 3) the use of online proctoring services as a way to control cheating in the online environment.

3. METHODOLOGY

This study was conducted at two small mid-Atlantic Universities during the Spring 2021 semester (March to May 2021). The research adopted a quantitative methodology to assess how student / faculty trainings and availability of resources impacted students' final grades when they were suddenly moved to online learning during the COVID-19 emergency pandemic. The population for this study included all students aged 18 and over at both universities. One hundred and thirty-nine students responded to the survey, which was conducted using Survey Monkey, an online tool used to gather and organize data. The dataset was imported into a statistical tool, SPSS, for additional analysis that used Chi-square with a statistical significance of less than .05 margin of error and a 95% confidence level. The convenience sample surveyed students enrolled in courses from the School of Arts and Humanities, Business, Science and Math, Engineering, Computer Science, Computer Information Systems, Criminal Justice, and Psychology. The study explored the following two research questions?

RQ1: What impact did technology have on students' final grades during the COVID-19 Pandemic?

RQ2: How did the availability and accessibility of technology resources impact the students learning during the COVID-19 Pandemic?

The survey consisted of 20 closed-ended questions and one open-ended question for further understanding of students' experiences while moving to a remote learning environment during the COVID-19 pandemic. The first set of questions focused on background information about the students' gender, level of education, and school / department affiliation. The subsequent set of questions focused on the students' course delivery method during the pandemic, the LMS / tools available for the courses, and the trainings provided by the university to the students and faculty. The participants also answered questions on their performance in the course, availability / usage of technology, and impact on their learning / final grades in the semester. Lastly, the students had an opportunity to respond to an open-ended question on how the COVID-19 pandemic impacted their final grades.

4. RESULTS

All participants were asked a series of questions to understand their backgrounds which included their gender and level of education. Of the 139 participants, 60.4% were male, 37.4% were female, and 2.2% preferred not to disclose this information. Additionally, it was important to assess the level of education for the students to ensure that each level had representation. Based on the students who responded, 19.4% were freshman, 15.1% were sophomores, 24.5% were juniors, 29.5% were seniors, and 11.5% were completing graduate / post-graduate degrees.

Assessing how the students were impacted from the switch to remote learning required the researchers to analyze the delivery format of courses prior to the switch in learning. Early in the Spring 2020 semester, 46% of the students reported having at least one face-to-face course while 25.2% of students reported having at least one hybrid course that contained both face-to-face and remote learning components. These students were potentially impacted by the shift to remote learning as the core in-person instruction

of their course had to suddenly change. Over 75% of the student population reported that they were required to move to remote learning which aligns with the number of students who reported having some face-to-face instruction in their course delivery. It is important to note, that even though only 75% of the students reported a change to their learning mode, nearly all students were impacted in some way. It must be stated that 100% of students were taking online classes during the pandemic but 25% were fully remote prior to the lockdowns which resulted in 75% of students reporting the immediate move to online. For example, students enrolled in fully online courses had faculty members that still taught the traditional face-to-face courses. And while their fully online courses had been designed and unchanged during the pandemic, many faculty had to divert their time and resources to the converted courses which left limited bandwidth to collaborate with students in the unchanged online courses that were already in flight.

Switching to remote learning required the university and faculty to introduce new tools into their coursework. An important component to successfully transition students to remote learning is the training of faculty to teach remote classed and 54% of the students reported that their instructor seemed adequately trained for the transition while 46% believed that their instructors were not prepared for the move to remote learning. Students were asked which tools they used to bridge the gap with remote learning and the training they received for these tools. Of the participants, 62.6% used video conferencing tools, 32.4% used discussion boards, 2.9 % used collaboration tools, and 2.2% used phone calls. While these tools were incorporated in the students learning, 33.8% reported they received training on the new tools while 66.2% reported they did not receive training. A deeper analysis of the different tools and training provided for each is available in Table 1 located in the Appendices.

As students transitioned to this new environment, the university and external organizations provided resources to help ease the transition. Of the respondents, 92.8% of the students stated they had access to adequate technology to complete their course, while 7.2% reported they did not. Students were then asked to select the technologies that were used within their course and were permitted to select as many that applied. The results of this question can be found in Table 2 below.

Course Technology Needed	Percent of Participants
Computer	97.1%
Webcam	82.0%
Microphone	84.2%
Printer	31.0%
Internet	95.0%

Table 2: Course Technology

While it is assumed that the initial contact point for student assistance during this transition was the university itself, only 29.5% of the students stated the university did provide the resources while 70.5% stated the university did not provide any resources. Of the students who responded that the university did not provide the resources, 46.9% stated they had to purchase the technology needed to complete their coursework. To fill this gap, students were asked the funding source needed to acquire the required technology which includes the university, scholarships, relief funds, parents, job, other, or no funds were needed. Students who reported "other" stated alternatives such as nothing was provided, or they went through private loans to get the funding. The summarized results of this question can be found in Table 3 below. Finally, students were asked if acquiring this technology posed an undue burden (financial or otherwise), and 76.3% of the students responded it did pose an undue burden while 23.7% said it did not.

Source of Financial Assistance	Percent of Participants
University	2.9%
Scholarship	4.3%
Relief Funds	9.4%
Parents	15.8%
Job	19.4%
Other	3.6%
None Needed	44.6%

Table 3: Financial Assistance

The survey asked students a series of self-assessed questions to understand the impact COVID-19 had on their course and grades. The first question asked students if they did better in this new environment compared to their traditional face-to-face classes. Of the respondents, 32.4% reported they did worse, 36% stated they did not see a change, and 31.6% stated they did better. Subsequently, students were asked if the change in instructional delivery impacted their grade and 54% reported it had an impact on their final grade while 46% stated it did not have an impact. Since this impact could be either positive or negative, the students were asked to provide the level of impact from

extremely declined to extremely improved. Only 2.2% of students extremely improved, while 18.7% improved, 50.4% had no change in grades, 26.6% had grades that declined and finally 2.2% of student grades extremely decline. These results can be found in Table 4. Additionally, students had an opportunity to provide additional feedback on how the learning and course grade were impacted and their responses are summarized below:

- Extremely unmotivated to do class work combined with working during the week…
- It made learning harder for multiple reasons, but mainly the busy work became overwhelming.
- Honestly, I am just so burnt out and tired of looking at a screen.
- I feel as if I learned significantly less and my grades have declined.
- As far as learning goes, I feel like I learned nothing when moved fully online.
- A lot of the professors have never taught online and they didn't do a good job.
- Remote learning does not have the same level on engagement.
- Online courses are graded easier by far. The bar is set very low.
- The quality of the course material declined.
- Remote learning made everything extremely disorganized in every fashion possible.

Final Grade Impact	Percent of Participants
Extremely Improved	2.2%
Improved	18.7%
No Change	50.4%
Declined	26.6%
Extremely Declined	2.2%

Table 4: Final Grade Impact

While students' responses to these questions were an important aspect to understand how their grades were impacted, the researchers wanted to also analyze if there were any variables that were statistically significant with the impact on their final grade. The researchers found five variables that were statistically significant which included: doing worse in the new remote environment, having access to technology, having a computer needed in the course, the need for a webcam, and posing an undue burden on them. As expected, there was a statistical significance between the students' final grade and them reporting that they did worse in online courses. This had been a very difficult year for students and as the comments reported, students found it did pose an issue in their learning.

Two variables that show statistical significance answered the question of what technology impacted the students' final grades. As expected, using technology like a computer and a webcam had a direct relationship to the students' final grades. It can be assumed that the use of both tools keeps students more engaged in the course, less distracted, and able to retain more of what is being taught. Having a computer had a p-value of .024 for the Chi-square test, which fell within the range to be statistically significant. Many students who reported not using a webcam also commented that they felt distracted. The webcam had a p-value of .007 which also fell in the range to be statistically significant.

Also important was seeing if any variables showed a statistical significance related to the accessibility and availability of technology resources' impact on final grades. As one would expect, having access to technology had a statistical significance to the students' final grades. This variable had a p-value of .001 which not only fell within the range to be statistically significant but also was highly correlated with an impact on students' final grades. Students not getting the technology or just delayed in acquiring the technology, will certainly miss assignments or fall behind, thus causing a negative impact on their grades. Ensuring students have access would be a foundational component to their learning success. Secondly, the process of acquiring the technology causing an undue burden also had a high correlation with the impact on students' final grades. Specifically, this variable had a p-value of .012 for the chi-square test, which also fell within the range to be statistically significant.

5. DISCUSSION

Any swift change to our lives can be difficult but the more trainings and resources available to us can help ease the negative impacts of this transition. As the COVID-19 pandemic swept the nation in early 2020, many organizations underestimated its impact on their way of working. Some organizations simply needed to modify their business process to rely heavier on alternative methods that were already in use. However, for universities, the switch to processes such as remote learning seemed more impactful than they expected. Training the faculty and students and providing them resources for adapting to a modified learning environment needed to be handled carefully and with great

support. For some faculty and students, this was the first time they were entering a remote learning environment which warrants an entirely different design and implementation of instructional delivery plus a vastly different learning experience that adds a component of self-study to augment what we traditionally see as collaboration sessions in a traditional classroom. For this reason, it was important to understand what was available to students including trainings, resources, and funding to help acquire the needed technology to complete their coursework.

While the use of technology like discussion boards, video conferencing, and collaboration tools in pure online courses is not new, asking students who have never taken online courses to use these tools without proper training is a recipe for disaster. The study found that the two most-used tools were the discussion boards and video conferencing tools, yet only 33.8% of students reported that the university provided the training needed for this technology. With that number being so low, students would undoubtedly have trouble completing their coursework accurately and in a timely fashion. However, given the popularity of online courses, the researchers would find it hard to believe that the university did not have adequate trainings available for these tools. Likely the trainings were available, but students were not aware of where to find them or how to correlate them to their remote coursework. While subjective, 46% of the students reported that their instructors did not seem adequately trained for the online courses. Given that some instructors teach predominantly in a face-to-face setting and that the online learning delivery is vastly different, there is no doubt that the faculty members migrating their course content would likely struggle with this transition. This could explain why students felt the instructors were not adequately prepared.

Availability and access to the technology are two key components for student success in this modified learning environment. Fortunately, 92.8% of the students had access to the needed technology through some means. However, seeing only 29.5% of the students report that the university provided the needed technology was a bit discouraging. Luckily students were able to tap into a variety of sources, however, it is unclear if these sources were presented to the students by the university. In either case, the lack of university resources will certainly impact how students perform during this transition. While it can be understandable that the university provides on-site fixed resources like computer labs, the sudden requirement to shift learning remotely does require the university to intervene and ensure students are adequately prepared and have access to the needed technology. It is not expected that the university takes on the full financial burden, but many programs were available through government funding to help students with technology needs during this pandemic. It would be the university's responsibility to make students aware of these programs and help them in the process of applying and attaining funding for the needed technology.

Lastly, it is important to note that all students had some level of impact on their learning during the pandemic. This impact could be as minimal as their current online course instructor's limited bandwidth or as impactful like a financial burden causing students to either perform poorly or just withdraw from the university. For many students, this was their first academic year, or possibly even semester, and the abrupt change could be a demotivation to continue their higher education. Of the students who responded, 28.8% saw a negative impact on their final grade due to the COVID-19 transition. Ironically, 20.9% of the students responded they saw an improved impact due to COVID-19.

Fortunately, the open-ended question provided some additional context around the impact students faced. A few students did specify that their grades improved because they were forced to work hard and dedicate time to their studies. As a clarifier, one of these students commented that their grades might have improved because the instructors were more flexible and forgiving on grading during that semester. On the opposite side, students listed factors that led to their grades declining. The most common answer was being demotivated in the new self-paced environment as they did not have the drive to be successful while being so far removed from their instructor. A few students commented that the financial burden caused them to spend more time with their employers to pay for the additional resources. In turn, this caused students to have less time to dedicate to their coursework, which led to adverse effects on their final grades. Lastly, students also commented that they did not perform well in online courses as they prefer the face-to-face instruction since their learning styles require more direct and in person communication.

6. CONCLUSIONS

The COVID-19 Pandemic impacted organizations around the world and forced a new operating

model to be implemented, temporary or permanent, with their stakeholders. Higher education was not exempt and was forced to make quick adjustments to their instructional delivery to offset the social distancing requirements related to the pandemic. However, in doing so, universities must ensure that proper training and resources are available to students and faculty. If they are not made aware of these resources and supported in procuring them, then learning will be compromised.

This study found that resources were available internally and externally to the university, but students did not feel they nor their instructors had enough training to adopt the modified learning environment during the pandemic. A substantial number of students reported that they had an undue burden due to acquiring the needed technology and resources for their coursework. One might assume this would be financial only, but time is an element we must consider. If students are spending time on trying to attain funds for the technology, learning how to use the technology, or get frustrated because they are unable to follow through with procuring the resources, then inevitably, they are taking away core time that could be spent on instructional activities for their courses. The main take away is that while all training and resources could be available, universities should provide individualized attention, as needed, to ensure students are not only aware of what is available, but also able to easily procure what is needed. While we may not expect a future pandemic any time soon, at a minimum we should learn that awareness without support for instructional activity will likely negatively impact student learning in online environments.

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Appendices

Training Received	Collaboration Tools	Discussion Boards	Phone Calls	Video Conferencing Tools	Total
Yes	0%	8.6%	2.2%	23.0%	33.8%
No	2.9%	23.7%	0.0%	39.6%	66.2%
Total	2.9%	32.4%	2.2%	62.6%	100.0%

Table 1: *Student* Training versus New Tools Adopted

Variable	Chi-square Value	Significance Value
Gender	5.831	.666
Level of Education	21.218	.384
University Providing Training	2.417	.659
Worse Grade in Remote Learning	105.785	0.00
Access to Technology	18.187	.001
Computer Needed for Course	11.229	.024
Internet Needed for Course	5.352	.253
Webcam Needed for Course	14.053	.007
Acquiring technology posing an undue burden	12.795	.012

Table 5: Chi-Square Analysis with Impact on Final Grade

An Approach for Ushering Logistic Regression Early in Introductory Analytics Courses

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Abstract

Logistic regression (LoR) is a foundational supervised machine learning algorithm and yet, unlike linear regression, appears rarely taught early on, where analogy and proximity to linear regression would be an advantage. A random sample of 50 syllabi from undergraduate business statistics courses shows only two percent of the courses included LoR. Conceivable reasons for this dearth of LoR content is likely related to topic complexity, time constraints, and varying degrees of tool ease of use and support. We propose that these constraints can be countered by: [1] introducing logistic regression early, [2] informed tool selection prioritizing ease of use with comprehensive output, and [3] using/developing innovative, accessible, and easy to understand concept learning aids. This approach would leverage the proximity to linear regression and probability readily embed distributed practice for student understanding of a foundational technique.

Keywords: Logistic Regression, Flow Diagram, Predictive Analytics, Data Analytics, Flow Chart, Pedagogical Aid

1. INTRODUCTION

Logistic regression is a classical model in statistics used for estimating conditional probabilities (Berkson, 1944). Logistic regression is also foundational to predictive analytics in multiple ways: 1. Logistic regression is a supervised classification (machine learning) algorithm that is used in many problem classes that seek to predict the probability of a target variable. 2. Among competing machine learning classification algorithms, e.g., support vector machine (SVM), and random forest, logistic regression is relatively simpler, and it is aided by having a (familiar) analogy to linear regression. 3. Because it is relatively simpler, good enough and easy to implement, it typically serves as a benchmark model when performing analyses for comparison to other algorithms. 4. Lastly, logistic regression is a gateway to learning neural networks (in that, in neural network representation, each neuron can be conceived as a small regression classifier). For these reasons, it is not surprising that logistic regression is widely used and taught in predictive analytics. We argue that, for pedagogical reasons, logistic regression should be introduced early because, long-term retention has been shown, repeatedly, in the psychological sciences to be positively impacted by *distributed practice* (Dunlosky, Rawson, Marsh, Nathan, &

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Willingham, 2013). Specifically, distributed practice includes both *spacing effects* and *lag effects* where spacing outperforms massing (Benjamin & Tullis, 2010); and spacing with longer lags has advantage over spacing with shorter lags (Delaney, Verkoeijen, & Spirgel, 2010; Dunlosky et al., 2013). Thus, we argue, in the same way that probability and linear regression concepts are introduced early and repeated in subsequent analytics courses, introducing logistic regression would yield similar retention benefits for students.

However, logistic regression appears to be rarely taught in the foundational statistics courses that are part of analytics curricula. We argue that not teaching logistic regression in introductory statistics courses is a lost opportunity for leveraging the benefits of distributed practice that would be afforded by the teaching of linear regression in these courses.

The purpose of this paper is to: first, investigate the inclusion of logistic regression instruction and content in undergraduate business statistics courses. Second, we identify conceivable reasons and limitations why logistic regression, in contrast to linear regression, is rarely included in introductory courses. Thirdly, we propose workarounds to overcome these reasons and limitations. The proposed workarounds include, introducing logistic regression early, judicious tool selection that takes into account ease of use without compromising adequate concept coverage, as well as the development of innovative teaching aids to support instruction, student reviewing and distributed practice.

2. BACKGROUND

Logistic regression (LoR) is, broadly, like multiple regression but, where the outcome variable is a categorical variable and predictor variables may be continuous or categorical. In its simplest form, it allows us to predict which two categories a person or thing is likely to belong to, given other (additional) data. Although, the principles underlying logistic regression have a few parallels to ordinary least squares regression (OLS), logistic regression is rarely taught in foundational classes even though its analogy to OLS, and the instructional (time) proximity to both OLS and conditional probability on which it relies would be pedagogically advantageous.

We also see evidence of this absence of logistic regression in prior literature that outlines content maps for analytics programs. Sircar (2009) maps the analytics curriculum which includes a course on "Applied Regression Analysis in Business" that does not cover logistic regression. Similarly, Hill & Kline (2014) map content topics to student prior experience for each topic in a "Big Data Analytics" course development and roll out, show linear regression, both simple and multiple, are "partially covered in previous statistics courses", while logistic regression is a "new topic for *most* students".

The literature exploring why logistic regression is scarcely taught in business statistics courses is missing. However, the same issue has been explored in the social sciences, e.g., sociology (Linneman, 2021; Lottes, DeMaris, & Adler, 1996; Walsh, 1987) and psychology. Several explanations have been advanced: while statistics courses have grown and may also be taught, strictly-speaking, by non-statisticians (Utts, 2015); for instance, the analogy used in sociology is, statistics is taught within sociology departments (Linneman, 2021). In data analytics, analytics courses that require logistic regression may be taught within information systems, business or economics departments rather than by statisticians from math and statistics departments.

At the same time, the use of logistic regression (LoR) has also grown in popularity in other social sciences like sociology and psychology (which matters for data analytics minor programs looking to expand appeal to students from other majors), Linneman (2021) argues that because of LoR's widespread use in scientific literature (we would add, and in data analytics), student understanding of logistic regression would contribute to students' quantitative literacy. Linneman (2021) emphasizes a contention also made by Walsh (1987): "a grasp of logistic regression will not only assist students in their own research efforts, but it will also enable them to intelligently read and evaluate current research in their field" (p. 178). Student understanding of logistic regression, in data analytics, would expand the universe of problems (and their contexts) students are able to engage with; this is an approach that is superior to amassing repetitions in limited contexts (Schmidt & Bjork, 1992). Further, introducing logistic regression following linear regression is consistent with spacing strategies in pedagogy that are designed to optimize short and long-term retention of knowledge (Lyle, Bego, Hopkins, Hieb, & Ralston, 2020). In this particular case, a spacing strategy would leverage student understanding of both *probability* and *linear regression*, topics that are widely taught in introductory statistics courses. In this paper, we maintain that the absence of LoR

in content coverage early in students' exposure to related analytics content is a missed opportunity.

3. INSTRUCTIONAL GAP: DATA FINDINGS

We hypothesized that the teaching of logistic regression in introductory business statistics courses would be found in at least 10% of courses.

We then investigated the extent of the coverage of logistic regression in business statistics undergraduate, courses. We searched for publicly available business statistics syllabi, online, across the United States, randomly selected 50 sample syllabi and analyzed their learning outcomes and course outlines. Schools in our sample happen to be located in 25 distinct states. The sample consists of Research 1 schools, teaching-oriented schools as well as liberal arts colleges. They were primarily 4-year institutions with a large majority being AACSB accredited and, 68% our sample were public institutions.

Table 1 below, breaks down the broad characteristics of these institutions.

Institutional Characteristic	%
Program length:	
4-year	88
2-year	12
School Type:	
Public	68
Private	32
AACSB Accredited	76
Modality:	
On-ground	94
Online	6

Table 1. Institutional Characteristics from the Sample

From the sample, we found that only 2% of the business statistics courses covered logistic regression.

The 2% offerings for LoR compare to 88% of the same courses that offer simple linear regression and 76% that offer multiple linear regression. See Figure 1 below.

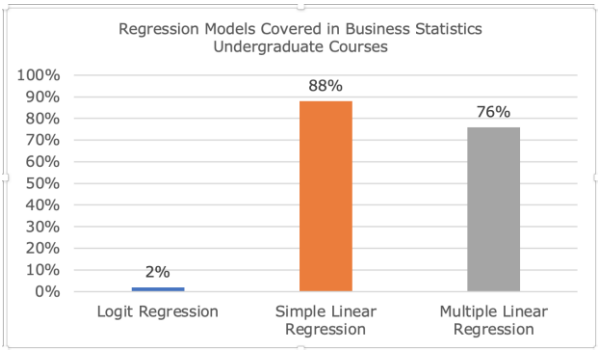

Figure 1. Sample of Business Statistics Courses: Comparative Frequency of Regression Model Coverage

We also found that there is a base of shared introductory topics within these offerings; primarily, these are: descriptive statistics; probability and probability distributions; sampling and estimation; and sampling distribution; [often included in this set is hypothesis testing and statistical inference, although this is not consistently offered. We will call this set, *Level 1* topics in an introductory business statistics course. Please note, correlation is frequently listed as a distinct topic from descriptive statistics in our sample syllabi.

In addition to *Level 1* topics, course offerings may also offer simple linear regression, multiple linear regression and (n)one to all of the following: Correlation, ANOVA, Chi-square (test for independence) and forecasting. We will call this set, *Level 2* topics.. Table 2 shows that simple (88%) and multiple (76%) linear regression are offered by many of the courses followed by correlation with 56% of the courses offering it. LoR is at the tail of the list at 2%.

Topic	Coverage %
Simple Linear Regression	88%
Multiple Linear Regression	76%
Correlation	56%
ANOVA	30%
Chi-square	22%
Forecasting	16%
Logit Regression	2%

Table 2. Level 2 Topic Coverage

In our sample, it is interesting to observe that among the Level 2 topics, while a large majority of courses cover linear regression (simple and multiple), in many cases, instructors/programs make decision choices between *Correlation*,

ANOVA, *Chi-square*, *Forecasting* and *Logistic Regression* (see Figure 2 below).

Figure 2 below shows the frequency with which combinations of Level 2 topics are offered. At the top, 74% of the courses offered both simple and multiple Linear regression (together, simply referred to as Linear regression in the chart). When we ask: In addition to Linear regression (the most frequently offered Level 2 topic), which additional topic(s) is/are offered? We found that only about half the courses also cover Correlation (48%) as a distinct topic, whereas 26% add ANOVA. 18% cover Chi-square in addition to Linear regression. 14% cover Linear regression and ANOVA and Chi-square. 12% cover Linear regression and Correlation and Chi-square. 10% cover Linear regression, ANOVA, and Chi-square.

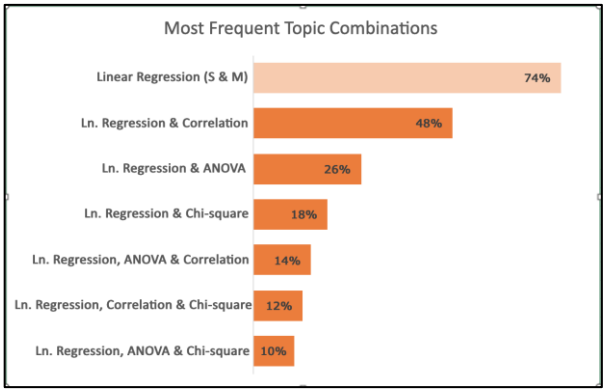

Figure 2. Most Frequent Topic Combinations

Lastly, we also found that there is an additional tier of topics offered within these courses. For example, we found syllabi that include *derivatives* and *optimization*; *capacity planning decisions*; *decision trees*; and index numbers (as in consumer and producer price indices). We will call this set, *Level 3* topics. There is less of a pattern to these offerings; they may be related to program/school or instructor specific priorities.

The data we gathered seems to, at least in part, support our prior experiential supposition that there is an instructional gap for logistic regression in introductory business statistics courses. While the specific reasons for this gap are subject to further empirical research, we do see evidence that the statistics courses we rely on as prerequisites of our data analytics curricula, on the main, do not introduce logistic regression (LoR). Below we explore and discuss this gap and propose some solutions.

4. DISCUSSION

Instructional gap: factors

The reasons for scarcity of logistic regression coverage in introductory business statistic courses may arise for several reasons. Reasons include, but are not limited to, the following: time constraints; the relative complexity of LoR, tool efficacy and easy access to the tool; and program/instructor priorities.

Time. Hill and Kline (2014) caution that one of the main challenges facing analytics instructors is the tension between the need to cover or review underlying knowledge/content and available course-time, that "*teaching tasks may take longer than expected. The instructor should be prepared to allocate additional class time or provide significant time for guidance outside of class*" (Hill & Kline, 2014, p. 6). Introducing LoR is likewise cast in this context.

Relative complexity. Though somewhat analogous to simple and multiple linear regression, forming and interpreting the logit function is relatively more complex for logistic regression. This complexity may be intimidating. Studies show that *affective* reasons are one of the reasons contributing to students' difficulty with interpreting and communicating the results of their analyses (Ashaari, Judi, Mohamed, & Wook, 2011; Reid & Petocz, 2002; Toskin & Kunene, 2021). There have been suggestions in the literature that (though unlikely in our belief) instructors may not feel necessarily comfortable to efficiently/effectively unpack the complexity for students (Linneman, 2021). This may also be attributed to instructors' own limited experience with (teaching) logistic regression.

Specifically, reasons why logistic regression is relatively more complex are: [1] unlike linear regression, we fit a regression model when the target or response variable is categorical (dichotomous in its simplest form), and ordinal. [2] Logistic regression differs from multiple regression because it is intended to predict the *probability* of an event occurring, or group membership, using a maximum likelihood estimation method. Additionally, the dependent variable can only take on two values, 0 or 1. Thus the probability must fall within this range. As a result, logistic regression uses a logistic curve rather than a linear regression relationship to model the relationship between the dependent and independent variables (Hair, Black, Anderson, & Tatham, 2009). The response or target variable therefore serves as a *classifier* in many problem applications.

There are additional key differences:
1. The coefficients are converted to log odds. Most people have difficulty thinking in terms of log-odds (Lottes et al., 1996)
2. Model fit cannot technically be assessed using R-squared. Pseudo R-square values may be used, with some caution, to assess model fit. There are multiple Psuedo R-squares measures to choose from.
3. Logistic regression introduces a classification table to evaluate the predictive accuracy of the (classification) model.

These differences may seem a bit harder for students to grasp and interpret initially.

***Tool efficacy and easy access*.** Compared to simple and linear regression, tool support for logistic regression is generally not as user friendly or necessarily easy, or cheap to access. For example, both MS Excel and R, which are easily and relatively cheaply available to most students, run good linear regression models generating comprehensive output. However, running a logistic model in *MS Excel* involves either multiple manual calculation steps together with the use of an Excel add-ins, e.g., Excel Analysis Toolpak that includes Solver; and/or teaching students how to use the open-source add-in, RegressIt for Excel or, the XLMiner Analysis Toolpak, or the LINDO add-in, *What's Best!*. These add-on tools add a layer of complexity. *Minitab* which is available to faculty and students at a large discount also supports logistic regression from a GUI interface (though the latest version no longer runs natively on MacOS). R, on the other hand, requires several lines of commands to create comprehensive output. Other software, like *Stata* also require some use of the command line and, unlike R, are licensed programs. This often means, in general, they are not necessarily easily available to students. IBM's SPSS, which may not be easily available to students, is easy to use and generates comprehensive output for logistic analyses.

Instructional gap: proposed solutions

In this subsection we discuss how strategic tool selection, and use of innovative teaching aids, may coalesce to afford time-savings that instructors can leverage to introduce logistic regression early.

Tool selection. Instructors use various tools in their introductory statistics courses, from Microsoft Excel, to Minitab, R, SPSS, SAS and Stata potentially. It is possible that some even introduce Python. A tool's ease of use while preserving key concept coverage are important considerations. We investigated which would be the easiest tool for novices to use for logistic regression; a tool that would also substantially capture key concepts.

We looked at the following tools, first on ease of use, then on substance. In other words, if a tool was not easy to use, we ruled it out by default then examined the remaining tools for capturing substance.

Tool	Ease of Use	Concepts
Excel, with add-ins	Low	
Python	Low	
SAS Programming	Low	
R	Low-Med	Med
Excel, XLMiner	High	Low-Med
Minitab	High	Med
SPSS	High	High

Table 3. Potential Supporting Technical Tools

Any tool that required students to write any form of code to run a logistic regression, we ruled out as too steep an "ease-of-use" bar to cross for an introductory course. Therefore, we discounted Python, SAS programming. R requires students to know additional commands for displaying key parameters of a logistic regression; we rated this as an ease-of-use hurdle. We did not assess SAS Enterprise Miner (EM) for data mining which is GUI based and includes a logistic regression algorithm, but the interface is geared towards data mining and machine learning which we believe is not suitable for an introductory statistics course.

Excel with Analytic Solver: while Excel is easy to use, and arguably Analytic Solver is not terribly difficult either, the steps required to perform a logistic regression in Excel are multifold and the extent of the output is restricted to estimating the coefficients of the equation. Additional work is necessary to generate goodness of fit information, and a classification table would not be included requiring additional add-ins like *What's Best!*. Using Excel with XLMiner was easy but severely lacking in output. It, too, is best for generating coefficients and their p-values. It also generates a model chi-square, however without the associated model p-values.

In the end, the remaining choices were Minitab and SPSS. The two products are both very easy to use. However, we found, SPSS produced richer output that is also easier to make sense of. We would recommend the use of SPSS for

introductory courses. In cases where students do not have access to SPSS, faculty could generate logistic regression output for an assigned task and have students focus on the interpretive components of the task. Selecting a tool that is easy to use (while preserving important concept coverage) is an important time-saving consideration.

Innovative teaching aids. To reduce the complexity associated with teaching logistic regression, a possible solution is to develop and/or utilize existing innovative teaching aids. A *visual artifact* for introducing students to logistic analysis is an example of a teaching aid. Following, Toskin & Kunene (2021), we created a an example of a visual aid for logistic regression that uses flow diagramming for interpreting logistic regression output for SPSS, the tool we found easier to use. In the following section we describe the flow diagram. The diagram is included in Appendix A.

The flow diagram (see Appendix A) focuses on five key steps:

1. Interpret significance of Chi-square statistic (p-value),
2. Interpret the *intercept* or constant.
3. Sequentially locate and interpret *coefficients* of the hypothesized independent variables and their respective p-values.
4. Evaluate common pseudo *R-square measures* for model fit (e.g., Cox & Snell R-squared, Nagelkerke) (not directly analogous with R-squared in OLS, interpret with some caution. In other words, not to be interpreted as explaining variance)
5. *Understand the "hit ratio" in the classification table to assess predictive accuracy of the model*. This step could also be undertaken earlier in the process, as a first or second step. It broadly answers the question, how accurately does the model classify (unseen) data?

When students use SPSS for logistic regression for the first time, instructors should draw attention to the fact that SPSS output generates a "null" or baseline model (with only a constant and no independent variables) followed by an estimated model with the chosen predictors (see Appendix B). The null model typically appears under the section named "Block 0" and an estimated model under "Block 1". Additionally, Block 1 includes chi-square statistic and its p-value, two pseudo R-square measures, i.e., Cox & Snell and Nagelkerke, beta coefficients along with their statistical significance based on the Wald test, and exponentiated beta value (i.e., Exp(B) which is easier to interpret). The output also includes a classification table that specifies the "hit ratio" and the overall percentage of cases correctly classified to the appropriate dependent group.

In the flow diagram, first we bring students' attention to the Chi-square value that measures the difference in change (the reduction) of log likelihood value between the base/null model which contains only an intercept, and the proposed model that includes specified independent variables. If the p-value of the Chi-square test is statistically significant students are directed to the next step, otherwise they are encouraged to re-evaluate the chosen independent variables in the model.

Step 2: we help students understand the value and meaning of the intercept or constant and its position in the logistic regression equation.

Step 3: students are directed to locate the regression coefficients for each independent variable, one at a time, and assess each p-value for statistical significance. If the regression coefficient is not statistically significant, the dependent variable and may be removed from the model. Otherwise, if it is statistically significant, students are routed to the next step which focuses on the interpretation of each coefficient value (for continuous and categorical variables)

A logit equation is also provided at that step to help students understand how each coefficient contributes to the overall prediction of the dependent variable (i.e., odds of success), and subsequently to use the model for estimation or prediction. Lastly, we introduced the antilog value, Exp(B), to help students interpret the magnitude of the coefficients.

In cases where independent variables are not significant, we assume that with guidance from faculty or prior knowledge, the regression model will be rerun either in a stepwise fashion and/or by selecting new variables, and the process of interpretation will start from the beginning.

Step 4: students are directed to examine pseudo R-square values i.e., Cox & Snell and Nagelkerke R-square used in SPSS to broadly assess model fit and interpret their meaning emphasizing that, in general, a higher percentage or value indicates a better model fit. We note here that instructors may want to however point out that these pseudo R-square values are to be used with caution, they do not explain variance as in linear regression.

Examining the model's classification accuracy is functionally more useful.

In *Step 5*, we highlight that this is a classification problem by asking the student to determine the predictive accuracy of the model by examining the "hit ratio", i.e., the percentage correctly classified using the classification table. The higher the percentage of correctly classified cases, the stronger the predictive accuracy of the model.

To help students transition from linear regression to logistic regression, this visual aid draws on similarities between the two techniques. For instance, the multiple linear regression teaching aid (Toskin & Kunene, 2021) focused on five key elements: significance F (p-value for the F statistic), the *intercept* or constant; *coefficients* of the hypothesized independent variables and their respective p-values. Here, for logistic regression, we draw students' attention to logistic regression concepts with near analogy to take advantage of what we can assume is, recent, student prior knowledge. This would alleviate the need to review or (re)introduce analogous regression concepts thus serving as time-saving affordance.

Program/instructor priorities, time.
In Figure 2, we show we found that only 2% of our sample courses covered logistic regression, while 74% covered linear regression (Level 2 topics). We also observe that even among Level 2 topics, there is some level of choice-making by programs or instructors (Figure 2). In other words, only some of Level 2 topics are found in an introductory business statistics course. Priorities are chiefly about purpose and time or, preference.

In this paper we argue for the inclusion of logistic regression early as a priority based on proven pedagogical strategies for long-term retention and the importance of logistic regression in analytics. Recognizing that there are time constraints, we have proposed a couple of affordances for time-savings. Nevertheless, if the case for logistic regression is made, what then could instructors trade off from available list of tradeoffs? It will depend on priorities. We would suggest leveraging concept proximity especially for those concepts that students are more likely to find complex. This would imply, if two topics compete for time and importance equally, and one has near analogy to a covered topic or concept, and the other not, prioritize the one with analogy and cover it with proximity to its analogy.

We would expect introductory courses that restrict themselves to Level 1 topics only (i.e., also exclude linear regression) are necessarily exempt from this discussion in part because they may be taught as 2-credit courses. However, for courses that do offer Level 2 and 3 topics, introduction to logistic regression may be included using the approach proposed in this paper. It may or would require the exclusion of one extant topic from Level 2 or 3, e.g., ANOVA or decision trees, with discretion. Furthermore, correlation and chi-square can also be introduced in proximity with their concept relations, e.g., correlation with descriptive statistics.

The benefit of introducing LoR resides in offering undergraduate students the advantage of learning logistic regression, an important foundation in analytics, through strategic proximity and strategic repetitions, a pedagogical approach associated with better long-term retention.

5. CONCLUSION

In this paper, we establish that logistic regression is foundational to predictive analysis and, in the social sciences. There are many problems that are, and can be, expressed as binary predictive problems. And yet, based on our investigation logistic regression is rarely taught in introductory business statistics courses. Our findings are consistent with evidence from the work of Hill & Kline (2014) that logistic regression is (also) rarely taught in introductory statistics courses we rely on for analytics curricula.

We explored three challenges as likely contributing to the absence of logistic regression introductory courses. These challenges are time constraints, relative complexity, and tool efficacy and easy access. In our experience these challenges are not mutually exclusive and are interrelated. Therefore, reducing at least one of the challenges helps alleviate the remaining two constraints. Furthermore, taking advantage of the (time) proximity to linear regression (plus analogy) and proximity to probability concepts, teaching logistic regression early would embed *distributed practice* along the students' introductory analytics courses, with a better likelihood of increasing retention (Benjamin & Tullis, 2010; Delaney et al., 2010; Dunlosky et al., 2013) and therefore reducing perceived complexity for the student and *reducing the time needed for reinstruction*.

The appropriate choice of tool (i.e., its ease of use and relative comprehensiveness) is an important

decision when attempting to address the above challenges. A tool that is easier to use and can generate comprehensive output (without requiring advanced skills) would reduce the amount of time needed to produce meaningful output from the analysis, ultimately reducing some of the complexity in performing analyses. Thus, freeing instructional time for work on comprehension and interpretation

Similarly developing or utilizing aids that are easier to understand and assist students in unpacking concept density, for example visual aids, has an effect on time and complexity constraints. In this paper we provide an example using flow diagraming, a proven pedagogical aid for unlocking complexity for novices. Such an aid can be used to strengthen students' capacity to interpret and communicate analysis for binary logistic regression models. Furthermore, the flow diagram can be reused by students each time a new model is generated irrespective of the number or type of independent variables used, and it can be used by students in subsequent courses where logistic models are used. In that sense, it also lends itself to repetition and spacing strategies.

Data analytics is a growing area for employment and career development. Data analysts and data scientists are in high demand with average salaries that remain in good health for both junior and senior analysts. The growth in undergraduate analytics programs offers opportunities for students to enter a fruitful and financially rewarding field upon graduation. Logistic regression is a base competency in analytics, a gateway to many applied classification problems, undergraduate analytics students should be strategically afforded repeat encounters with it to gain competency.

Teaching logistic regression soon after linear regression would not only take advantage of students' immediate understanding of linear regression, it would also give an opportunity to a larger body of students to experiment with an important analytics technique using problem examples they are likely to recognize. For analytics programs, this matters if we want to expose as many students as possible to the types of problems students encounter in the field.

The contribution of this paper is, first, we show from empirical data that there is evidence that logistic regression is indeed excluded from instruction in the undergraduate business statistics courses that analytics curricula rely on (despite its relevance to both business analytics and data science curricula). It is conceivable that this influences its lack of coverage in introductory analytics courses identified in Hill & Kline (2014). We then explore conceivable reasons and limitations for why logistic regression, in contrast to linear regression, is rarely included in these introductory courses. Our findings also show that programs/instructors already make choice decisions in deciding which topics to prioritize particularly with respect to Level 2 and 3 topics. Lastly, we have proposed some mechanisms for instructors to subvert these constraints. Our proposed approach seeks to leverage both pedagogical strategies (proximity to analogy and repetition) and innovative aids to reduce the amount of time it would otherwise take to introduce logistic regression.

Finally, we support the design of creative mechanisms to enable students to readily access content and unlock complexity that would help students early in their academic careers. The development of similar aids for other topics on the *analytics content map* may help serve as part of a library of supplemental aids to be used in fill-in-the-gap approaches (Bauman & Tuzhilin, 2018) for the teaching of analytics. The example flow-diagramming aid introduced in this paper as well as those in Toskin & Kunene (2021) may serve as part of a potential library of accessible and supplemental materials for introductory data analytics courses that instructors can assign or recommend to their students as a mechanism for closing knowledge gaps in practicable ways that recognize *time constraints* and the need to support a range of students in our analytics classes. We believe each aid is most effective and accessible where it is focused on a specific purpose and designed to minimize *complexity* for its audience. Flow diagramming is proven in this sense, for complexity reduction and therefore as a time-saving affordance for new learners.

6. LIMITATIONS AND FUTURE RESEARCH

Though cognizant of time constraints, that adding some topic (i.e., logistic regression) implies forsaking another, we have not stipulated which topic may or should be excluded to accommodate logistic regression. Specifically, the answer depends on context and program objectives but, even for the general case, it is a question we will explore in future research."

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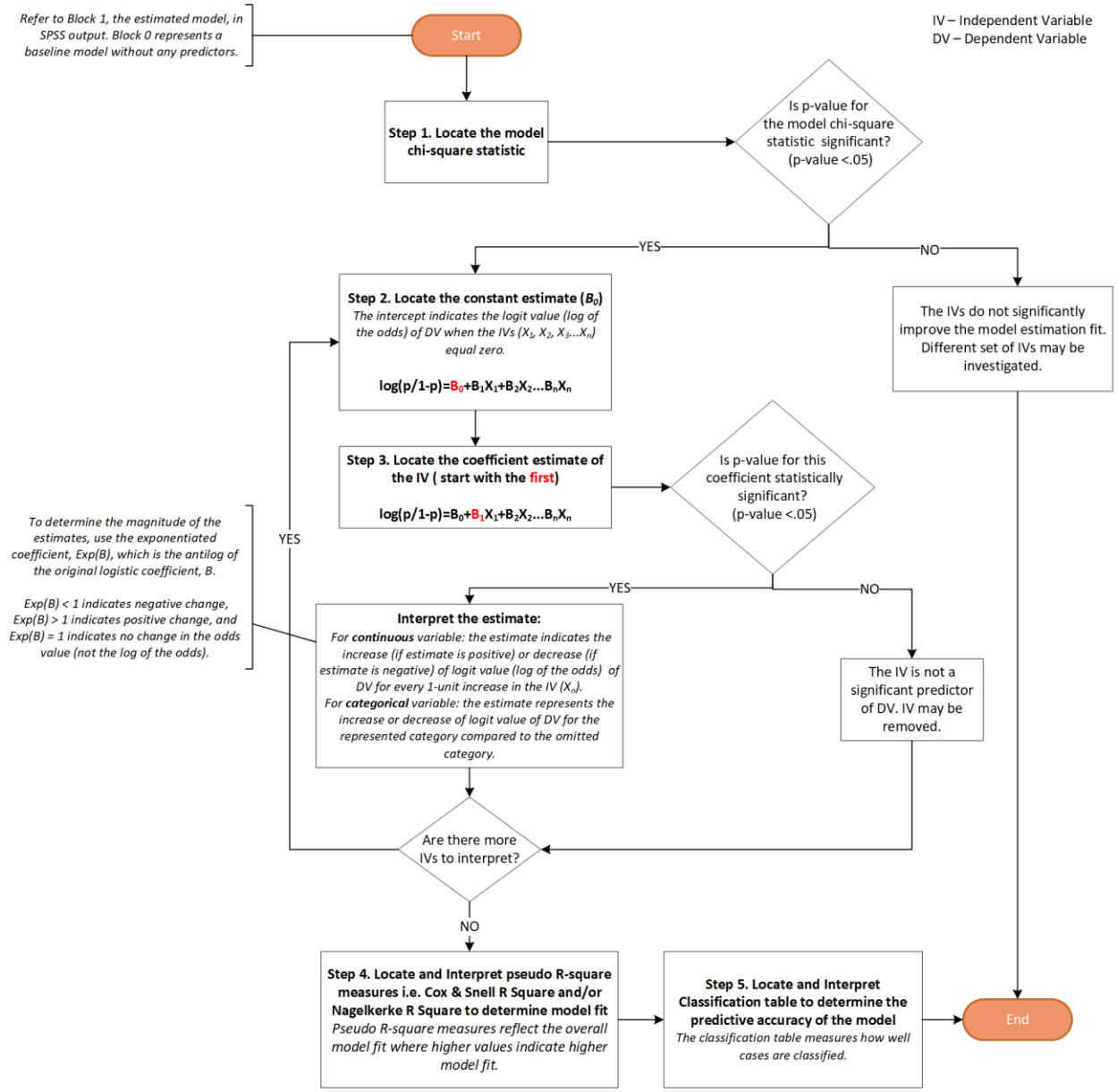
Appendix A

LOGISTIC REGRESSION FLOW DIAGRAM



Appendix B

EXAMPLE OF SPSS OUTPUT FOR LOGISTIC REGRESSION ANALYSIS

Logistic Regression

Logistic Regression - Case Processing Summary - July 10, 2021

Case Processing Summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	392	51.0
	Missing Cases	376	49.0
	Total	768	100.0
Unselected Cases		0	.0
Total		768	100.0

a. If weight is in effect, see classification table for the total number of cases.

Logistic Regression

Logistic Regression - Dependent Variable Encoding - July 10, 2021

Dependent Variable Encoding

Original Value	Internal Value
0	0
1	1

Block 0: Beginning Block

Block 0: Beginning Block - Classification Table - July 10, 2021

Classification Table[a,b]

Observed			Predicted		
			DIABETES		Percentage Correct
			0	1	
Step 0	DIABETES	0	262	0	100.0
		1	130	0	.0
	Overall Percentage				66.8

a. Constant is included in the model.

b. The cut value is .500

Block 0: Beginning Block

Block 0: Beginning Block - Variables in the Equation - July 10, 2021

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-.701	.107	42.674	1	.000	.496

Block 0: Beginning Block

Block 0: Beginning Block - Variables not in the Equation - July 10, 2021

Variables not in the Equation

			Score	df	Sig.
Step 0	Variables	pregnant	25.804	1	.000
		glucose	104.252	1	.000
		pressure	14.552	1	.000
		triceps	25.677	1	.000
		insulin	35.617	1	.000
		mass	28.602	1	.000
		pedigree	17.177	1	.000
		age	48.241	1	.000
	Overall Statistics		135.543	8	.000

Block 1: Method = Enter

Block 1: Method = Enter - Omnibus Tests of Model Coefficients - July 10, 2021

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	154.077	8	.000
	Block	154.077	8	.000
	Model	154.077	8	.000

Block 1: Method = Enter

Block 1: Method = Enter - Model Summary - July 10, 2021

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	344.021[a]	.325	.452

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Block 1: Method = Enter

Block 1: Method = Enter - Classification Table - July 10, 2021

Classification Table[a]

			Predicted		
			DIABETES		Percentage Correct
	Observed		0	1	
Step 1	DIABETES	0	233	29	88.9
		1	56	74	56.9
	Overall Percentage				78.3

a. The cut value is .500

Cyber Insurance Concepts for the MIS and Business Curriculum

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Abstract

As the twenty-first century advances technologically, the era is also becoming notorious for the rise of organized cybercrime and attacks on business information and operations. Company data and intellectual property are considered the "New Oil" that generates value for organizations and their constituents. With the escalating number of cybersecurity incidents, businesses—especially small and medium-sized enterprises (SMEs)—are increasingly at risk of compromise and economic debilitation. Therefore, current and future business students would benefit from awareness of unfamiliar measures, such as cyber insurance, which can potentially reduce the devastating effects of a cyber incident. In this paper, the authors describe cyber insurance, present a framework that could be incorporated into the classroom to teach risk management techniques, and provide exercise resources.

Keywords: Cyber insurance, Teaching strategies, Cyber defense education, Risk management

1. INTRODUCTION

The far-reaching effects of the SolarWinds cyber and the Colonial Pipeline ransomware attacks provided a wake-up call to American businesses and consumers. The White House recognized the seriousness of the vulnerabilities faced by Americans and, on Thursday, June 3rd, 2021, issued a letter to business leaders encouraging them to be vigilant in protecting their organizations from ransomware attacks. In the letter, Christopher Wray, Director of the FBI, likened the attacks to the terrorism of September 11, 2001 (Mitchell, 2021).

A 2020 survey conducted by the New York State Department of Financial Services (DFS) found a 180% increase in ransomware claims between 2018 and 2019; the survey also noted that the average cost of associated claims rose 150%. The numbers continue to escalate with the department reporting that claims nearly doubled in 2020 (Dullea & Levy, 2021).

Due to the rapidly growing number and sophistication of cybersecurity incidents, it is crucial that current and future business professionals be familiar with measures that organizations can take to mitigate and reduce risks. In general, undergraduate business programs typically offer a MIS course as part of the core business curriculum, or as an elective that all college of business students can take. Almost all undergraduate Introduction to Management Information Systems (MIS) textbooks contain a chapter introducing students to information systems security concepts. Therefore, the MIS course provides a great

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opportunity to expand general business students' knowledge of risk management techniques and cyber defense tactics for protecting the data of their future employers (Frydenberg & Lorenz, 2020).

One concept that has received little attention in both the MIS curriculum and industry is cyber insurance. Many business leaders are unfamiliar with cyber insurance and its associated risk management requirements. Insurance rater AM Best Company noted that cyber insurance is now a primary component of corporations' risk management and insurance purchasing decisions (AM Best, 2021). In this paper, the authors discuss the growing need for general business students to be aware of cyber insurance, cyber defenses, risk management devices, and policies required before such insurance may be secured. They also then suggest strategies for incorporating these topics into business curriculums.

2. CALL TO ACTION

A 2017 article in The Association of Collegiate Schools of Business' (AACSB) BizEd magazine advocated for the incorporation of cybersecurity content coverage in higher education business courses (Weiser & Conn, 2017). After most universities had moved to an online format in response to COVID-19, an article in AACSB's *Insights* noted that times of crises often create innovations with lasting longevities. The author encouraged business schools to use their developing cyber practices to "…infuse cyber hygiene into every course of study" (Limayem, 2020). Recently, FBI Director Christopher Wray noted that, "There's a shared responsibility, not just across government agencies but across the private sector and even the average American" to prevent the disruption caused by cyberattacks (Mitchell, 2021).

Knapp, Maurer, and Plachkinova (2017) noted that a growing number of colleges and universities are offering specialized programs in cyber security. A search for the phrase "cyber security education" yielded a number of articles describing cyber security programs around the world. However, in a 2021 article in Cyber Insurance Academy, the author noted that "…insurance professionals lack the basic technical knowledge needed to carry an intelligent conversation with clients about cyber insurance" (Simkin, 2021). Steps, however, are beginning to be taken in that direction with the development of an interdisciplinary, open, general education cybersecurity course (Payne, et. al., 2021).

The article describing the course mentions a discussion assignment in which cyber insurance is one of the many types of businesses created within the cybersecurity domain. However, cyber insurance, as well as the risk management devices and policies that insurers are requiring for securing such coverage, should be addressed in greater detail. The U.S. Government's Cybersecurity and Infrastructure Security Agency (CISA) has recognized that need for some time. Since 2012, the CISA has partnered with various stakeholders, including academia, to find ways to expand the cybersecurity insurance market's ability to address the area of cyber risk (CISA, 2021).

The following sections provide a primer focusing on cyber insurance concepts. The sections describe cyber insurance, the first defined framework used by insurers to evaluate corporate cyber risk, steps that companies can take to address risk using the framework, and suggestions for incorporating this material into learning programs including discussion questions and a student-tested security mini-case exercise.

3. CYBER INSURANCE: WHAT IS IT?

The CISA described cybersecurity insurance as being "designed to mitigate losses from a variety of cyber incidents including data breaches, business interruption, and network damage" (2021). Cybercrime can take many forms, including ransomware, malware, phishing, IP theft, and Distributed Denial of Service attacks (DDoS), among others. The CISA believes that requirements for obtaining cyber insurance have the potential for reducing devastating cyber security attacks. The reduction would result from the preventative measures insureds would institute to qualify for insurance and lower premium charges (CISA, 2019).

Should a company be involved in a data breach, it may face both direct losses to the business as well as liability to others. Some of the costs that a company may incur include: forensics for determining the extent of the breach; legal expenses to determine the appropriate response to the breach; notification to those affected by the breach; establishment of a hotline, credit or identity monitoring for those affected by the breach; documenting the attack; quarantining the compromised hardware and software; containing and eliminating the threat; analyzing activity logs; implementing security improvements; costs of the actual losses from the breach; possible lawsuits resulting from the

breach; legal defense costs; missed sales due to system downtime; canceled contracts with business partners; lost customers; activities to minimize the loss of customers; damage to the business' reputation; a public relations firm for damage control; costs to acquire new customers; regulatory penalties and fines; and other costs (Durfey-Hoover_Bowden, 2021; Milne, 2021). If the breach results from a ransomware attack, the company may decide to include the additional cost of paying the ransom. However, ransom payment does not guarantee data recovery and some attackers are keeping copies of the data for future income from double extortion (Tuttle, 2021).

Following the Colonial Pipeline ransomware incident in May 2021, experts believe that both state and federal governments will soon begin requiring companies to secure cyber insurance policies. Obtaining those policies will be difficult without first bolstering infrastructure and cyber defenses within the organization. Peter Halprin of Pasich LLP (an insurance recovery law firm) suggests that regulators, like New York's DFS, are "putting the onus on companies to prioritize cybersecurity." Businesses cannot take an "ostrich-like head-in-the-sand approach" by "discovering vulnerabilities and [then] ignoring them." (Rice, 2021).

4. CURRENT STATUS OF THE CYBER INSURANCE INDUSTRY

AM Best reported that the number of standalone cyber insurance policies increased 28% in 2020, evidence of the growing concern about cyber risk (AM Best, 2021). Coalition, Inc., a cyber insurance provider, published a report examining their policyholder claims for the second half of 2021. They noted an increase in average claim costs between the first and second halves of the year. They reported that average claim costs, in relation to business revenue size, were $149,427 (revenues less than $25 million), $303,925 (revenues between $25 and $100 million), and $357,659 for business earning $100+ million in revenues (Coalition, 2022).

In the 2020 annual survey on cybersecurity insurance policies conducted by the National Association of Insurance Commissioners (NAIC), the organization found that the amount of cyber insurance premiums more than doubled from 2015 to roughly $3.15 billion in 2019 (Matthews, 2020). In addition, the 2019 average loss ratio for those reporting rose from 34.5% in 2018 to 48.2% in 2019 (Matthews, 2020).

The increase in premium cost is understandable when considering the losses incurred by a breach. For example, in a study conducted by IBM Security and the Ponemon Institute of 537 real breaches across 17 different countries and 17 different industries, the researchers found for 2021 that the average per record (per capita) cost of data breaches under 100,000 records was $161. Of the institutions surveyed, the largest share of breach costs (38%) was attributed to lost business including customer turnover, system downtime, and costs associated with obtaining new customers (IBM Security, 2021).

The growing number of cybersecurity incidents is causing insurance underwriters to re-evaluate their practices and pricing algorithms. The AM Best report listed some of the major challenges that the cyber insurance industry faces including rapid growth in exposure without adequate underwriting controls; a growing sophistication of cyber criminals who have been able to exploit vulnerabilities faster than companies can address them; and the far-reaching implication of the cascading effects of cyber risks and the lack of geographic or commercial boundaries" (AM Best, 2021). Guidance and regulation in the cyber insurance industry has been limited except for the inroads made by the states of California and New York. Thus, when seeking current cyber insurance materials to incorporate into college curricula, faculty should look toward the cyber insurance developments transpiring in not only their own jurisdictions but also those of California and New York.

5. STATE AND FEDERAL REGULATION

The NY DFS has recognized that insurers issuing cyber policies are operating in an area characterized by rapid growth and uncertainty. Insurers have incurred losses due to "non-affirmative" or "silent" risks that are not explicitly included or excluded from property/casualty policies (Lacewell, 2021). The cyber insurance industry is faced with "escalating costs [that] are creating pressure to increase rates and tighten underwriting standards for cyber insurance" (Lacewell, 2021). To support the cyber insurance providers in maintaining financial stability while protecting the people and entities they insure, the NY DFS developed the first Cyber Insurance Risk Framework outlining best practices for managing policy risk. The Framework was developed through a series of meetings with insurers, insurance producers, cyber experts, and insurance regulators across the U.S. and Europe (Lacewell, 2021).

Because future graduates may one day purchase cyber insurance, it is important to be familiar with the direction that insurance companies are receiving from legislative bodies, as well as the framework by which they are formulating policies and thus, pricing policies. In addition, within the Framework, recommendations are made to insurers to gather information about the insureds' governance policy, operations policies, processes, and controls as well as security policies from third party business partners. According to Joshua Mooney, a cyber practice attorney, "Merely evaluating one's cybersecurity policy is like checking to see if the front door is locked, while all your windows and back door remain wide open. Good cyber hygiene is demanded by business partners, regulators, consumers, and specifically in more and more state and federal laws" (Rice, 2021). The quality of a company's risk management program and protective measures will be factored into the determination of the insureds' policy premiums. The following section outlines the NY DFS Framework for insurers to keep in mind as they sell policies. This framework can be used as an outline by instructors for incorporating cyber security concepts into the classroom.

6. REFERENCE FRAMEWORK: NY DFS BEST PRACTICE

Through a series of meetings with knowledge experts, the NY DFS formulated the seven best practices listed below to help insurance providers manage their cyber insurance risk. The authors of the framework noted that cyber insurance risk will vary based upon variables such as the insurers' size, resources, geographic distribution, market share, and industries insured (Lacewell, 2021).

1. **Establish a Formal Cyber Insurance Risk Strategy** that includes clear qualitative and quantitative goals.
2. **Manage and Eliminate Exposure to Silent Cyber Insurance Risk** by clearly communicating whether policies provide or exclude coverage for cyber-related losses.
3. **Evaluate Systemic Risk** of the individual insureds and the market as a whole. Risk introduced by insureds' third-party vendors, as well as their subcontractors, should be considered and plans developed to address the losses they may potentially induce. In addition, internal cybersecurity stress tests should be conducted on possible, but unlikely, catastrophic cyber events.
4. **Rigorously Measure Insured Risk**. Insurers should develop "a data-driven comprehensive plan for assessing the cyber risk of each insured and potential insured including corporate governance and controls, vulnerability management, access controls, encryption, endpoint monitoring, boundary defenses, incident response planning, and third-party security policies" (Lacewell, 2021).
5. **Educate Insureds and Insurance Producers** about cybersecurity and reducing the risk of cyber incidents as well as the measures they can adopt to reduce their insurance premiums.
6. **Obtain Cybersecurity Expertise by Recruiting** employees and consultants with cybersecurity experience and skills to better understand and evaluate insureds' risk.
7. **Require Insureds to Notify Law Enforcement** immediately to aid in the possible recovery of data and funds as well as prosecution of events.

In reviewing the framework above, four of the seven steps are directly affected by the insured entity's knowledge of cyber security including 3, 4, 5, and 7. Although steps 1, 2, and 6 in this framework relate specifically to the insurance provider, they should also be addressed by the insured entity and are also included in the Cyber Security Framework developed by the National Institute of Standards and Technology (NIST). The NIST Framework (complementary to the NY DFS version) was developed to provide "voluntary guidance, based on existing standards, guidelines and practices for organizations to better manage and reduce cybersecurity risk" as well as aid in internal and external cybersecurity conversations (NIST, 2021, para 6).

The framework is used by insurance providers to systematically evaluate companies in determining a company's risk exposure and calculating cyber insurance premiums. Thus, by knowing what the insurance industry identifies as an area of potential vulnerability, the framework provides a systematic outline around which faculty can discuss risk mitigating tactics. In the next section, the authors suggest risk management concepts that faculty can incorporate into their Introduction to MIS course curriculum that align with the DFS framework.

7. USING THE NY DFS FRAMEWORK TO INCORPORATE CYBER INSURANCE CONCEPTS INTO BUSINESS CURRICULA

As state and federal governments develop their requirements and recommendations for best

practices to protect against cyberattacks, businesses should be proactive in adopting these actions. Thus, all future business professionals should have a general working knowledge of cyber insurance concepts. Although general MIS textbooks normally have a chapter dedicated to information security, little detail is provided about cyber insurance. In this section, the authors recommend five topics that could be incorporated into the information security section of any course that aligns with the NY DSF framework.

7.1 Baseline and Advanced Measures

Minimizing risk of cyberattack benefits both the insured and insurance providers through enhanced protection and cost savings from lower premiums/payouts and fewer events requiring remediation. Cyber insurance experts recommend to businesses both baseline and advanced measures for decreasing the likelihood of cyberattack and recovering expediently in the wake of a breach. Awareness of these measures correlates with NY DFS framework items 1, 5, and 6. Experts recommend first baseline security precautions, including:

1. **Creating backups,** especially critical in cases of ransomware attacks, and to also recover accidently deleted files and hardware failures, back-up offsite and not locally as ransomware is capturing the on-location sites.
2. **Patching and updating** systems promptly to maintain the security of operating systems, applications, and firmware.
3. **Antivirus protection,** although becoming less effective at preventing problems, companies should have something in place.
4. **Multi-factor authentication** is critical; proving user authorization by password, smartcard, cell phone, or by fingerprint or other biometric indicator (implementers should check the legal requirements of their state before using a biometric device, as it is restricted in some locations).
5. **Security policies** should be implemented and enforced, including an IT user policy, data management policy, and data destruction policy.
6. **Plan for the worst** by developing a business continuity plan, disaster recovery plan, and security incident response. Pay attention to reporting requirements of your state and industry regulators and be prepared to take action in compliance with the law about informing stakeholders of a breach or loss of data/privacy.
7. **Phishing prevention training** is important as about 90% of cyber attacks are rooted in phishing messages, attachments, and click-through. Security Awareness training is also critical for employees.
8. **Third party expertise** may be hired to test the system and identify weaknesses and issues in need of attention.

Cyber insurers will expect, at the very least, that the above precautions are implemented before a cyber insurance policy is contemplated (StaySafeOnline.org, 2021). Often a business balks at the thought of spending money to develop these baseline security measures; 80% of SMEs don't believe they are vulnerable to a cyberattack or potential data/privacy loss. Increasingly, if a breach occurs and the organization has not taken appropriate precautions, the organization may be liable legally. A good example of the importance of these basic preventive measures is recounted by a cybersecurity expert who was working with a healthcare organization to increase the company's cyber defenses. The expert recommended a multi-factorial authentication system to secure the group's sensitive healthcare information at a cost of around $8k to implement. The company refused to take this step due to the cost. Shortly thereafter, a provider's laptop containing patient information was stolen. The total bill for this completely avoidable breach was nearly $3.5 million (Staysafeonline.org, 2021).

Cyber insurance and security experts also recommend, depending on the nature of the company, a combination of additional detection systems and processes to help prevent and mitigate a cyberattack, including:

1. **Endpoint Detection and Response (EDR) Platforms** monitoring and collecting activity data from endpoints that could indicate a threat, analyzing data to identify threat patterns, automatically responding to identified threats to remove or contain them, notifying security personnel, and applying security incident and event management tools to research identified threats and search for suspicious activities.
2. **NextGen Antivirus (NGAV) Software** moves from the signature detection of malware to machine-learning by detecting threats through behavioral analysis; this is also cloud-based to provide faster detection.
3. **User/Entity Behavior Analytics (UEBA/UBA)** uses machine learning, algorithms, and statistical analysis to

detect changes in single user or entity (multiple users) behavior and analyze deviations from established patterns.

4. **Configuration Management and Application Whitelisting** involves identifying and tracking all company software and hardware assets; and indexing approved software with components that are cryptographically hashed and verified to prevent harmful applications.
5. **Segmentation** of networks when you have third party vendors or outside connections; external inputs should be isolated from the primary system by separate VLANs and firewalls.
6. **Outbound filtering** to detect traffic going to unauthorized IP addresses. All outbound connections should be sent through a proxy and monitored for anomalous IP addresses. (Cole, 2021).
7. **Dark Web monitoring** for personal information associated with a leak or data intrusion. Trustwave published a report in 2019 noting that credit card records may go for about $5.40 on the dark web, while (PHI) personal health information record prices may go as high as $250 per record. Thus, medical services are especially at risk.

7.2 Cyber Security Insurance

Romanosky, Ablon, Kuehn, and Jones examined 67 unique cyber insurance policies filed with state insurance commissioners. Their qualitative paper focused on three themes examining "(1) What losses are covered and excluded by cyber insurance policies, (2) What questions do carriers ask applicants in order to assess risk? and (3) How are cyber insurance premiums calculated?" (Romanosky, Ablon, Kuehn, & Jones, 2019). The authors noted that there can be losses resulting directly from the event (first party losses) and losses incurred as a result of litigation with injured parties. From examining the policies, the authors found that the ten most common covered losses included:

- Cost of claims expenses, penalties
- Public relations services
- Notification to affected individuals
- Services to affected individuals
- Business income loss
- Data or system restoration
- Forensic investigation
- Data extortion expense
- Costs from security breach; data loss
- Costs of damages

They found that the ten most common exclusions included:

- Criminal, fraudulent, or dishonest acts
- Negligent disregard for computer security
- Loss to system not owned or operated
- Bodily injury
- Contractual liability
- Acts of terrorism, war, military action
- Act of God
- IP Theft
- Seizure or destruction of systems by the government
- Fines, penalties, or fees

There are several factors involved in calculating the cost of cyber insurance such as the industry in which the business operates, the type of data that the company handles, the nature of the business, the location of the business, the size of the organization, the amount of risk exposure, the amount of coverage, and the size of the deductible, to name a few (Mak, 2021). In a study conducted by AdvisorSmith in 2020, the organization found that in general, annual premiums ranged from $650 to $2,357 for cyber insurance, based upon companies with moderate risks, liability limits of $1,000,000, a $10,000 deductible, and $1,000,000 in company revenues (Mak, 2021). In Romanosky, et al.'s (2019) presentation of their findings at PrivacyCon, the authors provided an example of the factors used to calculate the premium for a California insurance policy (Figure 1). Awareness of these insurance coverage and premium factors correlates with NY DFS framework item 2.

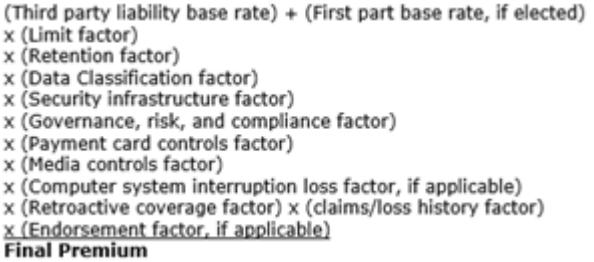

Figure 1: Example Cyber Insurance Premium Breakdown

7.3 Internal and External Audits

Cyber insurers emphasize "cyber resilience" as the key to a strong approach to defending against malicious attacks. Aligning to the best practices of NY DFS, experts recommend examining the security measures of third-party business partners to evaluate the security of the data pipeline. Such partners might include those providing services such as payroll, project

management, IT support, consulting, and financial accounting. A company may have its vendors rated through a System and Organization Controls (SOC) audit conducted by a third-party accounting firm.

During a SOC audit, the third-party auditors critically evaluate the company's data security, integrity, confidentiality, and privacy throughout the organization's operational processes

The result of the audit would be a SOC report, which service organizations (SO) may then share with their stakeholders as evidence that the SO's systems are being secured against breaches and intrusions that may place service data at risk.

In addition to these external audits, in-house canvasing of controls and operating effectiveness should be conducted by companies. Because cyber insurance providers expect clients seeking insurance to self-assess everything from corporate governance and controls to system vulnerability, businesses should be identifying and vetting their existing infrastructure, and making upgrades to improve their ability to secure cyber insurance at a reasonable rate. Awareness of these measures correlates with NY DFS framework items 3 and 4.

7.4 Reporting

NY DFS framework #7 specifies that it is critical for businesses to know what is required of the organization with regard to reporting the loss of individuals' Personal Identifying Information (PII). According to a November 20, 2020, report by the American Academy of Actuaries (AAA) Cyber Risk Task Force, "each state and territory of the U.S. has its own statute(s) covering the responsibilities of companies operating in that state in the event of cyber breaches of PII. These statutes include the delineation of covered information, notification requirements as well as potential penalties, and exposure to litigation resulting from a breach that exposes consumers' PII to outside parties." (AAA Cyber Risk Task Force, 2020, 3).

Because most commercial cyber breaches are regulated only at the state level, it is imperative that businesses be aware of their reporting requirements and obligations. Below are some of the considerations for businesses developing cyber defense response plans related to reporting:

1. **Scope.** This category varies by state and determines if your business is required to report to clients/customers in the case of a breach. Almost every state with a regulation compels commercial companies to report PII breaches.
2. **Covered Information.** The information subject to the law that must be reported varies; but for the majority, "covered PII includes at least first initial or name and last name in tandem with at least one of the following: Social Security number (54 states), driver's license number (53), financial account numbers combined with any code necessary to access the account (52), and any other unique identifier information provided by the state or other government body (46)." (AAA Cyber Risk Task Force, 2020, 7).
3. **Breach Definition.** According to the Cyber Risk Task Force, "in all jurisdictions except one, a breach is explicitly described as an "unauthorized" access or acquisition of unencrypted covered PII" (p. 9)
4. **SafeHarbor/Exceptions.** Again, according to the Cyber Risk Task Force: "in every jurisdiction, statutes do not apply if accessed data is encrypted (and the encryption key was not uncovered) or otherwise rendered unusable through redaction or other means." (AAA Cyber Risk Task Force, 2020, p. 9).
5. **Harm Threshold.** This factor relates to the level of potential misuse of the PII that was accessed. This varies widely among states; for example, "fourteen jurisdictions do not require notification unless there is a reasonable expectation that the covered information can be used to cause identity theft or fraud; 14 other states do not stipulate any harm threshold, so all breaches involving covered PII must lead to notification." (AAA Cyber Risk Task Force, 2020, p. 9).
6. **Consumer Notice.** The timing of required notice also varies considerably depending on jurisdiction. The average amount of time is 45 days between the time of the breach and when the consumer must be notified, but it can be as short as "as soon as possible" to as long as 90 days. The timing is critical because a number of states will fine businesses (ranging from $5,000 to $750,000 per infraction) that do not comply with the reporting schedule. Compliance also will benefit the organization in civil litigation as a show of good faith. Data breach notification laws vary by state; IT Governance keeps an updated database of current statutes at https://www.itgovernanceusa.com/data-breach-notification-laws.
7. **Other Notices.** A number of jurisdictions require governmental authority notification, such as to a regulatory body or attorney

general. The Consumer Reporting Agency (CRA) must also be notified in many jurisdictions. If the breached organization is holding data on behalf of a third-party, almost all states require notice to the third parties.

Awareness of, and compliance with, reporting requirements in the event of a breach are indispensable elements of a company's cyber attack planning protocol. Protection of client information and timely reporting is also essential to procuring a cyber insurance policy that will support the organization in the ever-more-likely event of a breach or data compromise.

7.5 Continued Education

Continuing to learn and maintain currency in cyber security developments through established industry and security news sources and white papers correlates with NY DFS framework item 5. For instance, Trend Micro (2021) recently released a white paper noting that there is "a shift in the ransomware business model" with significant changes seen in payment and collaboration, ransomware monetization, and the vulnerability and exploit market. Some attackers are using ransomware affiliate programs, such as Ransomware-as-a-Service (RaaS), that are highly professional and user-friendly and offer almost no barrier to entry for would-be hackers (Fuentes, et al., 2021; Walter, 2019). Potential hackers provide either an "up front" payment or provide a share of the profits. Thus, the potential for an increased number of ransomware attacks is growing. Likewise, future business professionals need to be aware of preventative actions they can take. In the next section, the authors describe exercise that can be incorporated into the classroom.

8. INCOPORATION OF CONCEPTS INTO THE CLASSROOM

An option for introducing the concepts in this primer to students is through the use of "Tabletop Exercises" (TTX). (More information about TTX's can be found at https://www.cisecurity.org/ms-isac/tabletop-exercises-ttx.) Because training is crucial to responding appropriately in the event of a critical incident, short discussion-based scenarios can be key to creating awareness and highlighting preparation. We have included in Appendix I, a tabletop exercise based on cybersecurity issues, and in Appendix II, an additional resource guide to other scenarios and games which may be adapted for use in the classroom.

8.1 Mini-case

Appendix I includes a tabletop exercise designed and used by one of the authors for a healthcare database systems course. The course is taught to a combined group of undergraduate and graduate students specializing in healthcare administration. All of the students have had a foundational undergraduate MIS course in which they learned general MIS security concepts. The mini-case, focusing on IT infrastructure and security concepts, asks students to apply the concepts to a given scenario. The students are also asked to answer questions that can then be discussed in class. The assignment was successfully used during the fall 2021 semester.

8.2 Recent Developments Discussion

Faculty could use this article to provide an overview of security concepts as well as directly address the role of cyber insurance in business. This information could be used to supplement current course security content. After covering the content, faculty could ask students to find a current news article on a recent cyber breach and then have the students analyze the business and breach given the NY DFS framework or concepts provided in the article.

8.3 Tabletop Exercises

In Appendix II, the authors have included a resource guide to other tabletop exercises (TTXs) and games which may be adapted for classroom use. The resources include TTXs from educational and government centers focusing on varied scenarios, such as failed patches, phishing incidents, and ransomware attacks. Several game sites are also included, such as the NOVA labs exercise where students can defend a company under cyber-attack. The exercises can be used to discuss security gaps and infrastructure and policy issues that would require attention before applying for cyber insurance.

9. LIMITATIONS

As indicated throughout the paper, there are many factors involved in determining cyber insurance policy coverage and prices. Some of those factors are specific to the organization, while others are external. Legislation, regulations, and requirements associated with cyber security, incident reporting, and cyber insurance policies and requirements are constantly changing and vary by location and industry. In addition, the authors focused on requirements associated with the cyber insurance field in the U.S. and did not research international requirements.

10. FUTURE RESEARCH

The level of interest in cyber insurance is escalating. The amount of published information increased significantly over the year that the paper was under review. Future researchers may want to focus their efforts on examining the differences in security policies among various industries and organization sizes. Researchers may also consider interviewing security experts to discuss their concerns regarding risks, vulnerabilities, and policy compliance.

11. CONCLUSION

In this paper, the authors review relevant literature relating to the characteristics of cyber insurance and the state of the cyber insurance industry. As data reporting breaches continue to rise, it is critical that future graduates are aware of the need for cyber insurance in business, as well as the risk management efforts required to secure policies and protect organizations. The authors provided an exercise that they have incorporated into the classroom as well as made recommendations to help faculty incorporate cyber insurance content into their business curricula.

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Editor's Note:

This paper was selected for inclusion in the journal as an EDSIGCON 2021 Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2021.

APPENDIX I

Mini-case: Homegrown Security at Small Town Medical Clinic Discussion Exercise

Billy had just finished entering data and placed the last call on his list of patent reminders. He had thirty more minutes to kill before his shift would be over. He was looking forward to going home to try out a new multi-user group game he had learned about from one of his gamer buddies. He knew it wouldn't be right to play the game at the office, but he didn't see anything wrong with checking out the related informational link that someone had forwarded to him. He couldn't get the link to open on his phone, so he decided to open his personal email on his office computer. The gamer had really talked up this brand-new game, so he couldn't wait to try it out. Immediately after clicking the link on the forwarded email, the computer screen when dark and an ominous message appeared in red…

Billy had recently been hired to work part time as a scheduler at Small Town Medical Clinic (STMC), a two-physician practice located in southeast Missouri. His job was to enter data into the electronic medical record (EMR) system as well as to assist their new clinic physician, Dr. Jones, by scheduling patient appointments, fielding patient calls, and making calls to patients to remind them of their upcoming appointments. Once he was familiar with office operations, he would perform those tasks for the other physician as well.

The clinic used an older EMR system that was stored on a server in a back office and networked to two physician tablets, one nurse tablet, one PC at the front desk, Julie's (the new office manager) computer, and the backup computer that Billy used in the same back office where the server was housed. All of the computers had access to the EMR. The tablets, computers, and the server all had firewalls and antivirus software. All of the computers were connected to the Internet. The wireless hotspot was not password protected allowing both clinic employees and patients to easily access the Internet from mobile devices. The office manager oversaw all operations in the office including ensuring that the EMR and computers were in working order which included overseeing the contract for computer support. The clinic had recently contracted with a local IT consultant after their in-house part-time IT person left. The IT consultant was hired to fix problems, maintain hardware, install software updates and patches, monitor server traffic for suspicious activity, ensure working server backed ups, ensure data compliance, and be on-call to help with computer problems. The server was backed up once a week and the backup was then stored on Billy's computer. The current and previous weeks' backups were retained but older backups were overwritten.

Upon hire, Billy was given a network login and created an associated password that never expired. His login would allow him to access the server and Internet from any computer. Billy was also given a policy manual that explained office policies including an acceptable use policy for technology. He was asked to read the manual before his first day in the office. However, the manual slid under the front seat of his car, and he had forgotten about it.

Julie had scheduled a meeting for later that day to meet the IT consultant. She had several concerns about their current setup and wanted to see about purchasing some additional services. She wanted to make some improvements before something bad happened and they were sorry.

Questions for Discussion

1. Based upon the article and your knowledge, what concerns should Julie have about the security of the current system?
2. What additional IT services should Julie purchase?
3. Do you think Small Town Medical Clinic should purchase cyber insurance? Why or why not?
4. Assuming that you think they should purchase cyber insurance, what would need to be corrected before Small Town Medical Clinic could purchase cyber insurance?

APPENDIX II

Tabletop Exercise and Game Resource Guide

Tabletop exercises are often used by organizations to examine and discuss scenarios, roles, responsibilities and actions in an informal setting around a table. More information about tabletop exercises can be found at https://www.cisecurity.org/ms-isac/tabletop-exercises-ttx. The resources listed below focus primarily on security issues, creating awareness of the vulnerabilities in computer information systems, and the need for infrastructure upgrades, monitoring, policies, and cyber insurance. The scenarios indicate the types of holes in security frameworks that may need to be addressed before the organizations can apply for cyber insurance.

(1) Center for Internet Security. Resource located at Six-tabletop-exercises-FINAL.pdf (cisecurity.org).

Six scenarios are included in this resource, covering topics such as failed patching, malware infection, a hacking incident, cloud storage compromise, ghost employees on payroll, and ransomware attacks during a natural disaster.

(2) Washington Technology Solutions. Resource located at: https://cybersecurity.wa.gov/tabletop-exercises.

The site contains almost two dozen scenarios covering everything from DNS amplification attack to handling IT infrastructure during a pandemic. According to the site, "the goal of the tabletop exercise is to increase security situational awareness and to facilitate discussion of incident response in as simple a manner possible; targeting a time range of 15 minutes."

(3) Article: Game-based learning: A review of tabletop exercises for cybersecurity incident response training. Resource located at: https://onlinelibrary.wiley.com/doi/10.1002/spy2.126.

This article by authors Giddeon N. Angafor, Iryna Yevseyeva, and Ying He reviews commercial and academic tabletop resources and exercises.

(4) National Association of Regulatory Utility Commissioners. Resource located at: https://pubs.naruc.org/pub/615A021F-155D-0A36-314F-0368978CC504.

Guide to designing cybersecurity tabletop exercises which includes examples of scenarios (See Appendix A of the Guide). Issues include a ransomware attack, a cyberattack on regulated utilities, and a combined cyber incident and workforce disruption.

(5) FINRA. Resource located at: https://www.finra.org/sites/default/files/2019-10/2019_SFC_Cybersecurity_Guidance.pdf.

This site provides cybersecurity tabletop exercises related to security in small financial businesses. Exercises include phishing email scenarios along with detailed information about incident responses and operational plans for small financial businesses.

(6) FDIC. Resource located at: https://www.fdic.gov/regulations/resources/director/technical/cyber/cyber.html.

The FDIC created Cyber Challenge: A Community Bank Cyber Exercise to encourage community financial institutions to discuss operational risk issues and the potential impact of information technology disruptions on common banking functions. The site includes nine scenarios at small banking institutions as week as training videos.

(7) Ready.gov. Resource located at: https://www.ready.gov/business-continuity-planning-suite.

The site discusses Business Continuity Planning importance and processes with videos and software.

(8) Texas A&M. Resource located at: https://keeptraditionsecure.tamu.edu/.

The game resource at this site "is part of a series of games developed by Texas A&M Information Technology with the aim of promoting Cybersecurity Awareness Month. In it, a hacker codenamed "Bad Bull," threatens the traditions of the Texas A&M campus. To track the threat, the user needs to answer relevant cybersecurity questions while roaming the campus."

(9) The Fugle Company. Resource located at: http://targetedattacks.trendmicro.com/.

This resource is a game that poses a number of security related decisions for a corporate CIO: "In this game, a video is presented to the user where he can choose the strategy, the way forward, and a defined budget. The idea is to transform the user into a CIO at Fugle, Inc. with the power to make decisions to protect confidential company information exposed to possible security problems. The goal is to make good use of the budget by making the best decisions."

(10) NOVA Labs. Resource located at: https://www.pbs.org/wgbh/nova/labs/lab/cyber/.

This is an online game by PBS: "Take cybersecurity into your own hands. In this Lab, you'll defend a company that is the target of increasingly sophisticated cyber attacks. Your task is to strengthen your cyber defenses and thwart the attackers by completing a series of cybersecurity challenges. You'll crack passwords, craft code, and defeat malicious hackers."

(11) Cybersecurity and Infrastructure Security Agency. Resource located at: https://www.cisa.gov/cybergames.

CISA and the Pacific Northwest National Laboratory partnered to develop a series of educational cybersecurity games available on mobile devices. Each game presents simulated cybersecurity threats, defenses, and response actions. The games are available for download on Android and Apple iOS devices.

Beyond Competency: The Imperative to Foster Professionalism in Computing Graduates

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Abstract

The Computing Curriculum 2020 project report, CC2020, Paradigms of Global Computing Education prescribes a competency model for describing curricula that challenges baccalaureate curriculum design to integrate "knowing why" into a fifty-year tradition of guidelines focused on "knowing what." Prescribing this competency model is a call to action to understand the scope of society's aspirations dependent upon computing and, in turn, computing education. These aspirations remind us that the character of a computing professional is as important as her computing expertise. Computing professionalism demands a well-formed mindset, of which computing competency is an essential ingredient. We argue, however, that the whole recipe for professionalism in computing must recognize and reflect on its transformative impact on the systems of society, both technological and human. We extrapolate CC2020's competency model into a framework through which academia and industry can partner to advance computing as a profession by integrating the technological, sociological, and ethical dimensions of computing. Finally, we present a rationale of professionalism in computing where competent practice is informed by the critical aspects of accountability: risk, responsibility, and consequence, where developing a professional mindset of inclinations and dispositions of character is not ancillary, but essential to educating baccalaureate computing graduates.

Keywords: professionalism, competency, mindset, dispositions, accountability, computing education, curriculum design.

1. INTRODUCTION

Computing has become integral to virtually every aspect of contemporary life – as a tool for mediating and managing human interactions (Lyytinen and Yoo, 2002). Computing systems and applications can wield tremendous benefit and tremendous risk depending on the carefulness and vigilance of analysts, designers, developers, and managers of computing

applications. The benefits seem obvious, but there has been harm.

To prevent practitioners from developing software-driven systems that inflict harm, the Software Engineering Code of Ethics and Professional Practice includes eight principles and advice on applying them. The first and most important of these principles is that software engineers "shall act consistently with the public interest" (Gotterbarn & Miller, 2009, p. 67). When these principles are ignored or violated, the results can be disastrous. For example, 17 patients died because of overexposure to radiation in software-generated treatment plans that were inconsistently checked for adherence to standards for patient safety (Borras et al., 2004). In 1994, Aeroflot Flight 593 crashed and killed all 75 people on board because the pilot's son unknowingly disengaged the A310's autopilot control of the aircraft's ailerons. A few minutes later, the aircraft crashed into the Kuznetsk Alatau Mountain range (Aeroflot Flight 593, 2017). Similar examples abound on the Internet!

If baccalaureate computing education is to prepare students to be respected and trusted purveyors of the tools and services of computing, then our curricula must take account of *how* and *why* respect and trust are safeguarded. Simply summarized, computing graduates are expected to ply their trade in society as professionals. And although "professionalism" is a familiar festoon imprinted upon most published computing curricula, we believe that more explicit description and documented pedagogy are needed if this claim can be honored as a meaningful characteristic of a curriculum design.

Institutionalized professions in which certification and licensure are the norm have codified the definition (and assessment) of competencies in practice, in the context of tasks demanded of the profession. These traditions date back decades, even centuries, in professions like nursing (Johns, 1995; Miller & Malcom, 1990), medicine (Wear & Castellani, 2000), and law (Cramton, 1982). Furthermore, these competencies are defined mainly based on the knowledge, skills, and dispositions (or attitudes) practitioners must learn and master to excel in their careers of service to society.

This paper examines the CC2020 competency model, its potential in baccalaureate computing education to frame professionalism in the formation of graduates as professionals. Competency has the potential to transform computing education (Leidig & Salmela et al., 2020; Waguespack & Babb, 2019). Computing competency is an essential ingredient in computing professionalism. The prospect of shaping a mindset enfolding professionalism in a computing baccalaureate is compelling. And although a baccalaureate may only be able to inaugurate a graduate's trajectory toward professionalism, that is undoubtedly a critical trajectory worth pursuing. After examining competency-based curricula for computing, our paper concludes with a discussion of the computing profession as an institution.

2. CC2020: THE PRESCRIPTION FOR COMPETENCY

The mission of the CC2020 project […] is to produce a globally accepted framework for specifying and comparing computing baccalaureate degree programs that meet the growing demands of a changing technological world and is useful for students, industry, and academia. (Clear & Parrish et al., 2020)

The CC2020 report followed upon its antecedent, the CC2005 report, and therefore attempts to lay groundwork for a continuous expansion of academia's commitment to educating the computing professionals of the 21st century. CC2020 was neither engaged in evaluating nor modifying the content of any subdiscipline, but rather attended to how computing curricula might be advanced by means of analysis with the prospect of visualization for comparing curricula. Adopting a competency model for describing computing curriculum enables their authors and curators to coordinate using a normalized, encompassing epistemological framework.

The CC2020 competency model enables dramatically amplifying curriculum representation both in form and scope. Where the traditional form and primary focus of computing curriculum guidelines has been on the knowledge computing students need in terms of "knowing what," the competency model enfolds a depth of understanding in applying that knowledge, "knowing how." And perhaps the more radical enhancement is attending to "knowing why" one might want to apply what they know in a certain context and what result might be intended and assessed.

The simplicity of the competency model belies the sophistication and depth of reflection entailed. Competency obliges designer reflection: *what*, *how*, and *why* a practitioner should approach fulfilling a particular *task*. (See Figure 1.)

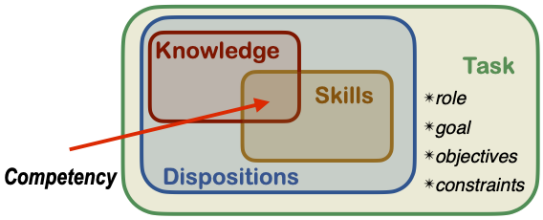

Figure 1: Competency = [Knowledge + Skills + Dispositions] in Task (Clear & Parrish et al., 2020)

The *Knowledge* component proceeds largely from the tradition of KA-KU (knowledge area, knowledge unit) ("knowing what") that predominated computing curricula guidelines until the recent IT2017 and IS2020. The *Skills* component derives from the Bloom's levels of cognitive process; effectively, how sophisticated is the practitioner's capacity of applying that knowledge ("knowing how"). Thus, knowledge always emerges as paired with a level of skill. (See Appendix C.) *Dispositions* refers to the temperament or quality of character ("knowing why") that inclines the practitioner to engage their choice of knowledge + skills. (See Appendix D.) The performative dimension of a specification of competency is situated by a statement of *task*, which defines a circumstance of risk, responsibility, and consequence. Performing a task entails intention or purpose that may be adjudged to a degree of professionalism. Essentially, a competency specification expresses a model of knowledge skillfully and purposefully applied in the successful accomplishment of a task.

3. CC2020: COMPUTING KNOWLEDGE

The CC2005 project performed an exercise constructing a taxonomy of computing based upon topics published in curriculum guidelines of the contemporary computing subdisciplines. CC2005's taxonomy was negotiated based on the member expertise of the steering committee. Although not empirically derived through analysis of actual guideline details, the taxonomy was very instructive. Among computing curriculum stakeholders familiar with it, the CC2005 taxonomy and comparison of topic emphasis continues to enjoy broad respect.

CC2020 reprised CC2005's taxonomy exercise with several cycles of proposition, negotiation, and refinement to update the topical cross section of scientific and technological computing knowledge. CC2020 arrived at 34 topic areas. (See Appendix A.) To further organize the topics the list is ordered based upon the semiotic ladder (see Table 1). The ordering ranges from concepts inherently objective or empirical (physical, empirical, syntactical) to those inherently subjective or critical (semantics, pragmatics, social world). Semiotic ordering clusters computing topics that generally associate as degrees of technically rational (physics, mathematics, logic, etc.) at one extreme and topics more generally regarded as degrees of subjectivity (management, sociology, psychology, politics, etc.) in the opposite direction.

Semiotic Ladder	Semiotic Layer Description
Social World	Beliefs, expectations, functions, commitments, contracts, law, culture
Pragmatics	Intensions, communications, conversations, negotiations
Semantics	Meanings, propositions, validity, truth, signification, denotations
Syntactics	Formal structure, language, logic, data, records, deduction, software, files
Empirics	Pattern, variety, noise, entropy, channel capacity, redundancy, efficiency, codes
Physical	Signals, traces, physical distinctions, hardware, component density, speed, economics

Table 1: The Semiotic Ladder (Stamper, 1991; Liu, 2000)

Once arranged semiotically, each steering committee member provided their estimate of the range of emphasis that each topic might be expected to represent for each of the six currently published computing subdisciplines (0-none, 5-most). The assembled estimates are shown in Appendix A. This appendix presents the average between the group's max and min emphasis yielding the bar graph in Appendix B for each topic juxtaposing the six subdisciplines. Thus, each subdiscipline's distinguishing balance of emphasis among the computing topic areas reveals its "fingerprint."

Computing subdiscipline description has long been preoccupied by a characterization of practitioners as "knowing what." CC2020 reviewed computing guidelines describing Information Technology, Information Systems, Cyber Security, Software Engineering, Computer Science, and Computer Engineering with others in development. (See Figure 2.)

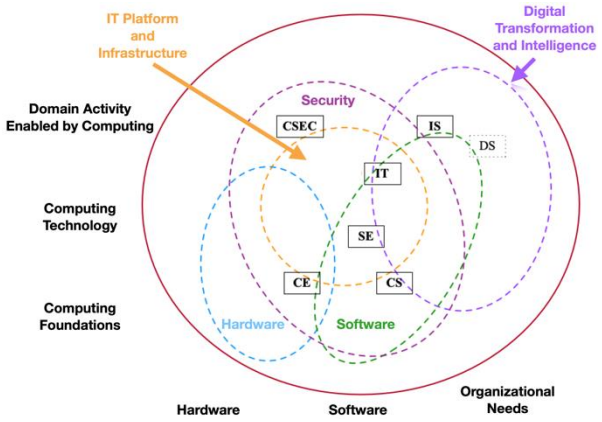

Figure 2: CC2020 Landscape of Computing

Adopting the competency model-based approach to curriculum description may elect the task domain as a more faithful, descriptive choice for identifying a computing subdiscipline (i.e., CS, SE, CE, etc.). But it is noteworthy that subdisciplines constantly evolve hyphenating with other domains although labels are resistant to change even if they are to some degree misnomers.

Competency-based curriculum description offers a perspective on disciplinary identity crystalized in two aspects: the combination of knowledge-skill pairs needed to act competently and the task(s) that demonstrate that combination applied. Dispositions introduces a mindfulness (*intension)* as a qualifier for "task well done."

4. FROM PROFESSIONALISM TO COMPETENCY

A computing practitioner "knowing what" and "knowing how" can perform an almost limitless range of tasks using computing. But the character of the consequence of that action determines the degree to which that behavior is adjudged professional.

Professionalism is often somewhat circularly defined: (Merriam-Webster.com, retrieved Sept 1, 2021)

Professionalism: the conduct, aims, or qualities that characterize or mark a profession or a professional person.

Professional: a member of a profession or earns a living from a specified professional activity. In addition, most professionals are subject to strict codes of conduct, enshrining rigorous ethical and moral obligations.

Profession: a calling requiring specialized knowledge and often long and intensive academic preparation.

Professional behavior is marked by a mindful reflection upon risk, responsibility, and consequence in the discharge of task. These elements are intrinsic to professional conduct. The scope and quality of reflection distinguishes the professional from the amateur. A competency specification frames computing knowledge applied skillfully in a practical context of task informed by dispositions reflecting an attitude inclined toward a task well done.

Competency provides a versatile template for describing units of purposeful behavior, work. A system of competency-based specification can be used to define a course, program, curriculum, discipline, licensure requirements, or a job description. But the goals and objectives of CC2005 and CC2020 were never intended to stipulate or propose the extents or granularity of computing professionalism. Indeed, the CC2020 report discusses only in broad strokes a respect for humanity at large and individuals thereof. CC2020's competency model nevertheless provides a frame with which to describe the performative aspect of professionalism. The following describes the relationship between that performative dimension and a mindset of professional behavior.

5. DIMENSIONS OF PROFESSIONALISM

"Knowing what" and "knowing how" (knowledge + skills) bracket the operative potential of competency while dispositions inform the intensional, the motivation to act. Task specification sets a context within which behavior unfolds inspired by dispositions, mindful inclinations, to achieve a principled result, a task well done.

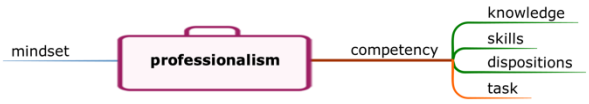

Figure 3: Competency inspired by mindset.

Competency Dimension – A competency-based curriculum defines a collection of tasks that define a domain of competency. Each task is elaborated by specifying the requisite knowledge and skill level to accomplish the task. Dispositions mediate the knowledge + skill application cuing reflection on risk, responsibility, and consequence. (See Figure 4.)

Dispositions can be defined as patterns of behaviors that are exhibited frequently and intentionally in the absence of coercion, representing a habit of mind. However, identifying desirable dispositions in engineering and computing education, or more particularly developing curricula with a goal to develop, reinforce or assess such dispositions is not common in engineering or computing. (Frezza et al., 2018; Frezza, Daniels & Wilkin, 2019; Frezza, Clear & Clear, 2020)

The CC2020 report proposes a set of eleven dispositions sourced from the literature of philosophy and theology (Newman, 2008; Frezza, Clear & Clear, 2020). A task defines the context of a competency, establishing the relevance of its knowledge and skills. Task descriptions provide an explicit context for describing, instructing, demonstrating, and guiding competency in action. Dispositions denote a desirable inclination for choosing and applying a competency to the effect of "good intentions." Where are the judgement points defined to be assessed in actions to be judged as "good?"

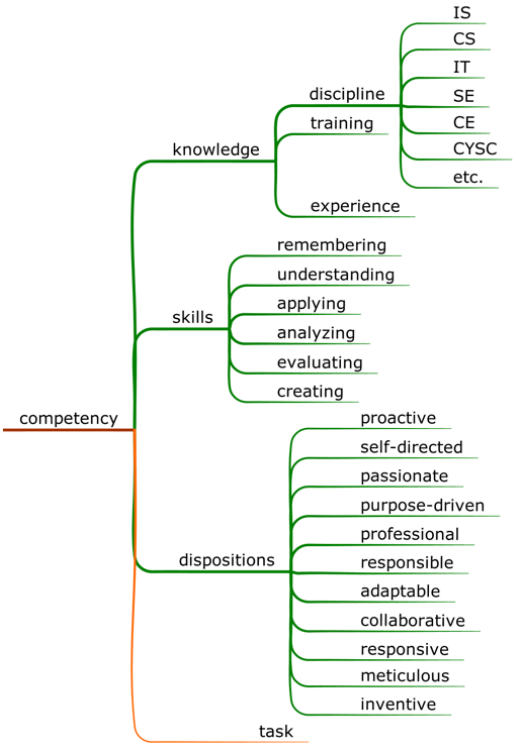

Figure 4: Competency Dimension

This question leads to Figure 5 that sketches a skeletal delineation of task elements. The flesh on that skeleton only emerges in the act of competency execution, accomplishing the task. Only in that execution can the practitioner realize the significance, priority, or urgency of the dispositions appointed to the competency. In effect, the practitioner channels "the mind" of the competency designer as she interprets design intention in the moment of the task. Congruence in that interpretation depends on the practitioner and designer sharing a mindset.

Mindset Dimension – In cognitive psychology a mindset represents the cognitive processes activated in response to a given task (French & Chang, 2016). In decision theory and general systems theory, a mindset is a set of assumptions, methods, or notions held by one or more people or groups of people. (Cambridge English Dictionary, retrieved Sept 1, 2021)

In the adapted quotations that follow, the design theorist refers to *mindset* as "appreciative system" and *practitioner* as "stakeholder" (Waguespack, 2019, p. 27).

A [practitioner]'s [mindset] cues what facts to attend to in any particular experience while that same experience results in a learning effect that informs, reinforces and refines the [practitioner]'s apprehension of value and significance, thus altering that [mindset].

[A… mindset] is a complex and emergent agency of choice in [practitioner] behavior situated in a social context.

[Practitioners] possess [mindsets] individually as their experience and judgements are personal. In a community of [practitioners] there are recurrent threads of experience, shared knowledge, and commonly held norms that proceed from culture: social, professional, religious, or intellectual. A culture commonly promulgates a standard of appreciation that facilitates a shared cooperation and collaborative decision-making that reinforces community – intentionally or unintentionally. Formal education, professional training, and certification, as well as, religious communities, all purposefully foster aspects of shared culture to shape community identity, goals, and expectations of behavior. Shared culture is a basic defining aspect of any community – formal or informal. Any human conception of satisfaction is founded upon [a mindset] that is subject in part to the subjective interpretation of norms and aspirations – individual and cultural metaphors.

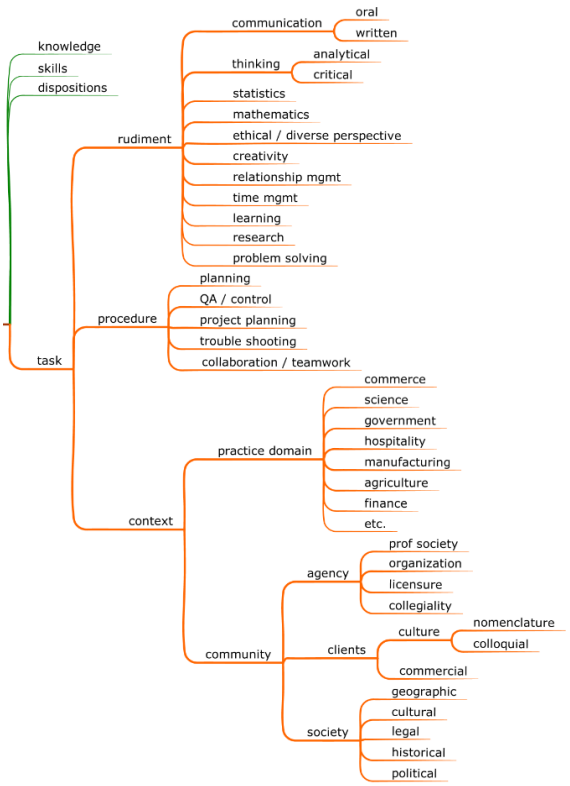

Figure 5: Competency: Task Aspect

Figure 5 lays out a portfolio of likely considerations, task characteristics that inform risk, responsibility, and consequence. The task graph denotes a figurative decision tree. The relevant variables amplified by enveloping dispositions to influence or prompt action. The significance of each variable would result from the immediate circumstance of the task at hand. While the literal processing of such a decision tree is conceptually possible, it is more likely that the assessment process will be navigated through the practitioner's tacit evaluation of the task informed by a mindset emerging from the practitioner's ongoing formal learning and practical experience.

It would be naive to presume that all combinations of disposition in an actual task context would be immune to tradeoffs. It would be further naive to assume that all "habits at hand" are beneficial or at least benign in every application of competency. It is the well-formed mindset that mediates the interpretation of disposition in the act of competent performance. That mindset must have a grounding in the values that are deemed appropriate for the professional engagement of competency.

Mindset Composition – Figure 6 characterizes elements of mindset that influence a perception of community "good." In the same spirit that CC2020 offered a prospective set of dispositions (see Appendix D), Figure 6 offers a nascent proposition for shaping the composition of mindset, a seed for discussion among designers to consider as they affirm a characterization of professionalism for their circumstance. One would expect such an explicit affirmation to be a necessary element of every curriculum description. This is a norm among professional societies who publish and renew their codes of conduct. Although we expect that well-formed mindsets of professionalism would have similarities among disciplines and subdisciplines within many cultures, we would also expect that particularities would merit variations.

Figure 6: Mindset Dimension of Professionalism

Figure 6 emerges from the authors' reflections upon their combined computing experience in professional and professorial practice.

Mindset inspires and justifies disposition. The introduction of dispositions by CC2020 represents a real potential for advancing the quality and effectiveness of computing curriculum description. It also presents a challenge and opportunity for our subdiscipline of information systems to renew the discussion of institutionalization in the IS profession.

6. DISCUSSION AND IMPLICATIONS

As a generative metaphor, we can conceive of the competency model as an affordance of detail and composition akin to adopting nutrition labeling that accompanies canned, prepared, and packaged food. This labeling creates truth in transparency so that the consumer can protect themselves and engage in self-regulation, should they elect to, rather than the food being of mysterious and uncertain origin and effect. The competency model provides a structure to articulate a similar level of transparency that suggests expected normative behavior upon which regulation and even cognitive disposition

can be shaped and adjusted. There is an imperative that computing leave its adolescence behind and engage in maturity, as an obligation to society to operate at a level of accountability commensurate with other professions. As with most imperatives, the imperative must be comprehended, felt, and executed upon by the individuals we will recognize as professionals in computing.

Professionalization as Imperative - While we ascribe a key to professionalizing within the context of the competency model as possession of mindset, it would require scholarship beyond the scope of this article to define and defend mindset in full. That said, the literature on professional practice and organizations is replete with references to this capacity. An intriguing take on this would be mindset as an acuity required for improvisation; a competency that is applicable nearly uniformly across computing disciplines. Weick (1998) and Schön (1983, 1987) offer a rich illustration of improvisation in music, e.g., jazz. These treatises are useful not only in reinforcing the necessity of mindset and the practices that reinforce mindset, but they also reveal how difficult it is to put into words the strength and promise of mindset.

The challenge is to deconstruct and comprehend how other clearly recognized professions came to be as such. We argue that some candidate components of the institutionalization that mature professions exhibit are the extrinsic and intrinsic conditions that sustain these professions as institutions. For clarity, we hold nursing, medicine, law, and engineering (Kolb & Wolfe, 1981) to be good exemplars, in part because they are universally comprehensible across cultures and societies. Few words are required to explain these professions beyond affordances for local variation. Even then, there is a practical and conceptual adherence to the institution of the profession such that regional variances do not dilute the core expected competencies.

Professionalism Institutionalized - The process of institutionalization can be articulated in cultural/cognitive, normative, and regulative dimensions (Birdwell-Mitchell, 2018). As the "legs of a stool," these are mutually reinforcing dimensions that sustain the institution even in the face of change. This is not to say that the institutions themselves are static, but they are often self-correcting to core values and principles even as they adapt to emerging circumstances. The practice of law, medicine, and engineering have undoubtedly changed in fundamental ways with respect to practice. Still, their core function remains true: for medicine, it is to heal without harm; for law, it is the fair application of justice; and for engineering, it is to develop artifacts that coexist reliably and safely in nature. The regulative dimension enshrines and defines the limits, consequences, and imperatives of professional practice for clarity. The normative dimension expects a concomitant degree of self-regulation for the organizations and societies that arise to foster and shepherd the discipline, for both neophytes and veterans. The cultural/cognitive dimension provides the processes of indoctrination that socially "glues" the other components such that one internalizes – develops a mindset – that assures, within a reasonable margin, that individuals will reliably adhere to the maxims of the profession and discipline.

As human processes, the dimensions of institutionalization are evolutionary and, at human scale, slow compared to advances in technology. While technology is undoubtedly a facilitating catalyst, aspects of the "three-legged" model of institutionalization rely on the slower processes of internalization, normalization, and acculturation. Respected and readily identifiable professions institutionalized incrementally over time, mostly in evolutionary response rather than by fiat.

Towards Accountability in Professional Practice - Alone, the social processes of institutionalization must resonate at the point of action – the point where an individual practitioner internalizes the profession within mindset. The imperatives that result in accountability exist broadly within paradigms of motivation (Maslow, 1981). We postulate the following elements for a professional mindset: assessment of risk, acceptance of responsibility, and accounting for consequence. While not exhaustive, each of these components suffuses the execution of competency and, in that execution, renews the tacit models that ensure future demonstration of competency such that execution remains within the tolerances of professional behavior. We propose that through reliable and accountable behavior, these imperatives foster the credibility and reputation that fully institutionalized professions exude. If the imperatives are not "felt" at an individual level, such that they produce dependable responses in the execution of competency, then any aspects attributable to professional behavior lose their potency.

Mindset suggests that imperatives for professional conduct are explicit and implicit in a continuum. An ability to respond to the

imperatives, aided by appropriate dispositions, can only be fully accomplished intrinsically. A suitable definition for this accountability is *being responsible for what you do and able to give a satisfactory reason for it, or the degree to which this happens* (Cambridge Dictionary, retrieved Sept 1, 2021). With this definition, there is no "other," only the individual called upon to competently execute. Regardless of external influences, the internal regulation of mindset makes professional competency a personal matter. However, individual execution does not imply a set of subjective responses; a professional practitioner acts in obligation to the norms, regulations, and culture that bounds professional practice.

The importance of institutionalized professions is the degree to which the public can depend on expected behaviors. In this regard, an institutionalized profession retains its viability according to the reputation it garners and protects. Thus, errant behavior must be censured and corrected in a manner that is knowable and known broadly. A suitable definition for reputation is *the opinion that people in general have about someone or something, or how much respect or admiration someone or something receives, based on past behavior or character* (Cambridge Dictionary, retrieved Sept 1, 2021).

A competency model for computing curriculum design can and should hold the process of institutionalization as a strategic outcome. Such an outcome demands that a profession's competent conduct be of high repute, with internal and external processes for regulation, normalization, and mindset. It is through these processes that institutions become worthy of respect, renewed in trust.

Authority and Public Trust - The last puzzle piece in institutionalization is authority. The need for authority is not apparent, as one would expect that regulation would attend to this need. However, regulation assumes some level of sovereignty. Respected and reputable professions assume sufficient internal accountability such that, in cases where sovereignty is clear, guidance on regulation is evident in partnership between legislative and practical elements. This partnership serves both to protect a profession's reputation - to engender trust, and to protect public well-being - to utilize trust.

We find that this notion, public well-being, is the most illustrative to comprehend the professional practice of competent application of computing knowledge and skills. While dispositions are as broad as individuals, imperatives to adopt a mindset suggest that indoctrination, in service to the public good, becomes a reasonable imposition. Should the successful and profitable application of computing skills remain the sole validator of the computing disciplines, then the process towards institutionalization will remain stunted; technology changes and the possibilities created lead to an ends-means equation of short-term thinking. Further, it is not clear to what degree markets recognize broader and long-term risk such that appropriate responsibility can be identified, and consequence can be accounted.

	Cultural/ Cognitive	Normative	Regulative
Risk			
Responsibility			
Consequence			

Table 2: Accountability and Institutionalization Matrix

The dimensions in Table 2 propose a rubric to explore the relationships among components of institutionalization and accountability to understand the imperatives for mindset. Connecting these components can lead to competent execution, such that dispositions are applied appropriately in a professional mindset. In sum, navigating Table 2 affords expositive exercises that explore dispositions as they relate to imperatives for professionalization.

Obligation to Act in the Interest of Public Well-being - Broadly, mindset may be most relatable to ethics. Many associations that arise to attend to the well-being of a profession, such as the Association for Information Systems, Association for Computing Machinery, and Institute of Electrical and Electronics Engineers, provide a codification of ethics. These are necessary to establish both the normative and cultural aspects of professionalization. Further, these associations often become involved in the regulative elements. Gotterbarn and Miller (2009) provide a compelling exploration of the facilities of codes of ethics for professional practice in computing.

Despite these measures, we propose that these codes have yet to achieve the imperatives that ensure obligation. There is not a code of ethics anywhere that, alone, will ensure that errant behavior is addressed and corrected. Other elements reflective of an institutionalized profession must also be brought to bear: at a

broad level, regulation, and at an individual level in cognitive and cultural dimensions. The number of parables, exemplars, and vignettes of the consequences of errors in computing is not sufficient such that imperative for action is clear and present.

While there are lessons for a range of stakeholders, we scope our focus to what we, in the academic "arm" of the computing disciplines, can do to aid in institutionalization.

There are implications for various roles and perspectives within the academy, where professional societies, administrators, and faculty may each influence norms, regulations, and culture. To achieve the same level of transparency that exists in our nutrition labeling example, we focus first on achieving transparency in curriculum design as clarity benefits each stakeholder. If we accept that facilitating processes of institutionalization create the ultimate imperative to act within the public interest (Gotterbarn & Miller, 2009; Gray, 2015), then the curricula we design does matter.

7. CONCLUDING REMARKS

In academia, our role remains the comprehensive and holistic preparation for professional endeavor via the education environment we provide in our institutions. In this charge, we have an opportunity to improve communication with stakeholder groups such that we are clear on the product that arises from our process. The articulation and execution of our curriculum, in various pedagogical modes appropriate to our circumstances and proclivities, is our stock in trade and forms the basis of our reputation. Whereas it may be sufficient to rely on other reputational signals at the institutional level, our most profound reputation is manifest in the subsequent journey our alumni forge. Rather than have the public believe this was the result of mysterious alchemy, situated in broad terms such as "IT, Security, or Project Management," we are at an inflection point where transparency will best serve the public interest. This is not to say that the public uses extensive and acute knowledge about the mature professions daily. Rather, the public trusts the mature professions and their institutions since their practices can be verified and updated, as necessary.

While the impact of computing on society, and thus on public well-being, is not disputed, our obligations to society are less clear. The elements that would accelerate the institutionalization of computing professions are known, but the catalyst that would cement these is lacking. Our audience here is our colleagues in higher education, and specifically within the information systems discipline.

There is a call for us to heed in the competency model promulgated within recent curriculum modeling efforts (Clear & Parrish et al., 2020; Leidig & Salmela et al., 2020). That call is to explore elements beyond knowledge and skills and forge into the realm of factors that shape competent and professional behavior that is worthy of respect and trust. In this manner, we have our reputation to protect such that our value proposition remains intact. Although often tacitly acknowledged, our value proposition must be explicated to include a broad preparation for professional practice that includes shaping of mindset. The value of our programs includes not only lucrative compensation for the profitable application of computing knowledge and skills, but the additional shaping of dispositions that is often, and colloquially, known as "character." Mindset and habit, perpetuated in lifelong learning through reflective practice, must accompany the application of knowledge and skills and must be molded explicitly in obligation to public well-being.

The competency model asserts that the shaping of mindset, dispositions, and habits is not out of scope, but rather is required. This is undoubtedly messy and controversial territory, but the imperative here is not to teach students what to think, but how to think, such that their competent professional practice is fully informed in the critical aspects of accountability: risk, responsibility, and consequence. Each transaction between task and competent execution to accomplish a task brings about the need for accountability to meet the obligations of professional practice. It is our charge to develop curricula that transparently satisfy this imperative. Furthermore, exploration of the processes of institutionalization is warranted to support our ability to mature as a discipline and to act in service to public well-being.

Understandably, some will ask a valid question here: but why do we need this? Whilst the societal impact imperative has been provided, a more concrete appeal may be in response to extant calls for increased professionalism from within the realm of practice. As a pragmatic matter, Bob Martin (2011) is among advocates for the orientation that competencies can deliver. Whilst it will not likely be the case that all practitioners will enter into the technology workforce as college graduates, among the

benefits of a baccalaureate program in computing could be this vital facet of the ethical imperatives that most societies and accreditors espouse and require. The public can better understand the value that computing provides to society with this leadership.

This paper has been a call and exploration of professionalism precipitated by the renewal of a competency basis for curriculum design that has arisen from both the CC2020 and IS2020 projects and reports. Among the premises for a competency-based approach is the degree to which competencies explicate expectations and verify their fulfillment. It is no longer permissible to continue to treat the societal byproducts of computing as being akin to mystery – certainly not for the public perception. There is a clarity in a competency's articulation not dissimilar to what nutrition information on packaged food conveys: what to expect and in what measure. We extrapolate from the opportunities presented within a competency-based approach to also push forward exploration and dialog on the matter of professionalizing the computing disciplines. If a competency-based articulation of computing curricula increases opportunities for clarity and accountability, we advocate that these maturing aspects be extended to the contracts and understandings we establish at a societal level, inherent in the execution of these competencies.

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Appendix A — CC2020 Landscape of Computing Knowledge

		CE		CS		CSEC		IS		IT		SE	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1. Users and Organizations	1.1. Social Issues and Professional Practice	2	5	2	4	2	4	3	5	2	4	3	5
	1.2. Security Policy and Management	1	3	2	3	4	5	2	3	2	4	2	4
	1.3. IS Management and Leadership	0	2	0	2	1	2	4	5	1	2	1	2
	1.4. Enterprise Architecture	0	1	0	1	1	2	3	5	1	3	1	3
	1.5. Project Management	1	3	2	3	1	2	4	5	2	3	2	4
	1.6. User Experience Design	1	3	2	4	1	3	2	4	3	4	3	5
2. Systems Modeling	2.1. Security Issues and Principles	2	3	2	3	4	5	2	4	3	4	2	4
	2.2. Systems Analysis & Design	1	2	1	2	1	2	4	5	1	3	2	4
	2.3. Requirements Analysis and	1	2	1	2	0	2	2	4	1	3	3	5
	2.4. Data and Information Management	1	2	2	4	2	3	3	5	2	3	2	4
3. Systems Architecture and Infrastructure	3.1. Virtual Systems and Services	1	3	1	3	1	2	1	2	3	4	1	3
	3.2. Intelligent Systems (AI)	1	3	3	5	1	2	1	2	1	2	0	1
	3.3. Internet of Things	2	4	0	2	1	3	1	3	2	4	1	3
	3.4. Parallel and Distributed Computing	2	4	2	4	1	2	1	3	1	3	2	3
	3.5. Computer Networks	2	4	2	4	2	4	1	3	3	4	2	2
	3.6. Embedded Systems	3	5	0	2	1	3	0	1	0	1	0	3
	3.7. Integrated Systems Technology	1	2	0	2	0	2	1	3	3	4	1	3
	3.8. Platform Technologies	0	1	1	2	1	2	1	3	2	4	0	2
	3.9. Security Technology and	2	3	2	4	4	5	1	3	2	4	2	4
4. Software Development	4.1. Software Quality, Verification and	1	3	1	3	1	2	1	3	1	2	3	5
	4.2. Software Process	1	2	1	3	0	2	1	3	1	3	3	5
	4.3. Software Modeling and Analysis	1	3	1	3	1	2	2	4	1	3	4	5
	4.4. Software Design	2	4	2	4	1	3	1	3	1	2	4	5
	4.5. Platform-Based Development	0	2	2	4	0	1	1	3	2	4	1	3
5. Software Fundamentals	5.1. Graphics and Visualization	1	2	2	4	0	1	1	1	0	1	0	2
	5.2. Operating Systems	2	4	3	5	2	3	1	2	1	3	1	3
	5.3. Data Structures, Algorithms and	2	4	4	5	1	3	1	3	1	2	2	4
	5.4. Programming Languages	2	3	3	5	1	2	1	2	1	2	2	3
	5.5. Programming Fundamentals	2	4	4	5	2	3	1	3	2	4	3	5
	5.6. Computing Systems Fundamentals	2	3	2	3	1	2	2	3	1	3	2	3
6. Hardware	6.1. Architecture and Organization	4	5	3	4	1	3	1	2	1	2	1	3
	6.2. Digital Design	4	5	1	2	0	2	0	1	0	1	0	2
	6.3. Circuits and Electronics	4	5	1	2	0	1	0	1	1	2	0	1
	6.4. Signal Processing	3	4	0	1	0	2	0	1	0	1	0	1

Table 3: Landscape of Computing Knowledge (Clear & Parrish et al., 2020)

It is worthwhile to note the data represented in this appendix and Appendix B record only opinion, albeit respected opinion. Note also that the CC2020 competency model is designed to support empirical curriculum data derived from competency specifications.

Appendix B — CC2020's Interpretation of Average Treatment by Subdiscipline Knowledge

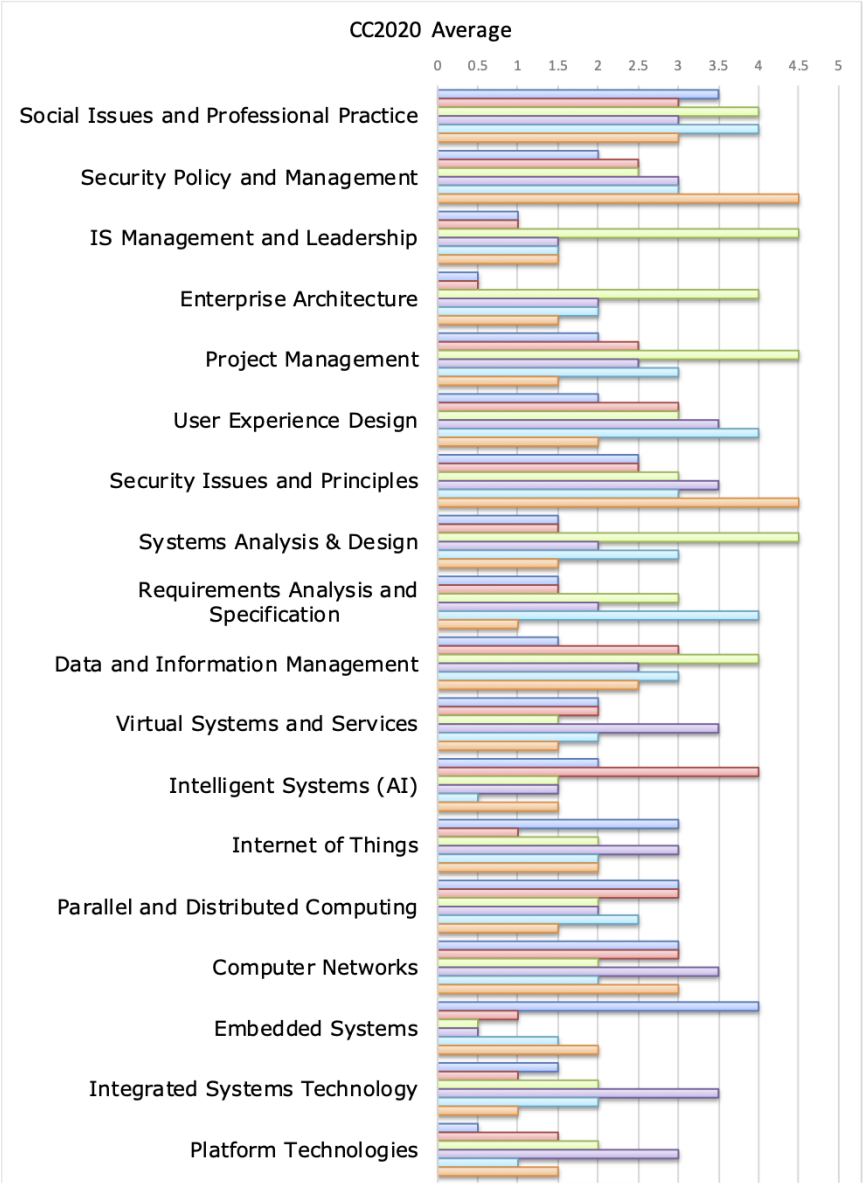

Figure 7: CC2020's Interpretation of Average Treatment by Subdiscipline Knowledge

It is worthwhile to note comparison presented here only reflects opinion, albeit respected opinion. The CC2020 competency model is designed to support empirical data derived from subdiscipline guidelines' constituent competencies, institutional program descriptions, and job descriptions; specifically, to facilitate intra- and inter-competency comparison. (This graph detail is more easily examined enlarged on your PDF reader application rather than in print.)

Appendix C — Revised Bloom's Taxonomy, Including Action Verbs (Anderson & Krathwohl, 2001)

Definitions	I. Remembering	II. Understanding	III. Applying	IV. Analyzing	V. Evaluating	VI. Creating
Bloom's Definition	Exhibit memory of previously learned materials by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.
Verbs	• Choose • Define • Find • How • Label • List • Match • Name • Omit • Recall • Relate • Select • Show • Spell • Tell • What • When • Where • Which • Who • Why	• Classify • Compare • Contrast • Demonstrate • Explain • Extend • Illustrate • Infer • Interpret • Outline • Relate • Rephrase • Show • Summarize • Translate	• Apply • Build • Choose • Construct • Develop • Experiment • Identify • Interview • Make use of • Model • Organize • Plan • Select • Solve • Utilize	• Analyze • Assume • Categorize • Classify • Compare • Conclusion • Contrast • Discover • Dissect • Distinguish • Divide • Examine • Function • Inference • Inspect • List • Motive • Relationships • Simplify • Survey • Take part in • Test for • Theme	• Agree • Appraise • Assess • Award • Choose • Compare • Conclude • Criteria • Criticize • Decide • Deduct • Defend • Determine • Disprove • Estimate • Evaluate • Explain • Importance • Influence • Interpret • Judge • Justify • Mark • Measure • Opinion • Perceive • Prioritize • Prove • Rate • Recommend • Rule on • Select • Support • Value	• Adapt • Build • Change • Choose • Combine • Compile • Compose • Construct • Create • Delete • Design • Develop • Discuss • Elaborate • Estimate • Formulate • Happen • Imagine • Improve • Invent • Make up • Maximize • Minimize • Modify • Original • Originate • Plan • Predict • Propose • Solution • Solve • Suppose • Test • Theory

Table 4: Revised Bloom's Taxonomy, Definitions, and Action Verbs (Anderson & Krathwohl, 2001)

Appendix D — Candidate Dispositions from The CC2020 Report

Disposition	**Elaboration,** adapted from (Baron & Kenny, 1986; Clear, 2017; Gray, 2015; Nwokeji, Stachel, Holmes, 2019)
Proactive	*With Initiative* / *Self-Starter* Shows independence. Ability to assess and start activities independently without needing to be told what to do. Willing to take the lead, not waiting for others to start activities or wait for instructions.
Self-Directed	*Self-motivated* / *Self-Directed* Demonstrates determination to sustain efforts to continue tasks. Direction from others is not required to continue a task toward its desired ends.
Passionate	*With Passion* / *Conviction* Strongly committed to and enthusiastic about the realization of the task or goal. Makes the compelling case for the success and benefits of task, project, team or means of achieving goals.
Purpose-Driven	*Purposefully engaged / Purposefulness* Goal-directed, intentionally acting and committed to achieve organizational and project goals. Reflects an attitude towards the organizational goals served by decisions, work or work products. *e.g.,* Business acumen.
Professional	*With Professionalism* / *Work ethic*. Reflecting qualities connected with trained and skilled people: Acting honestly, with integrity, commitment, determination, and dedication to what is required to achieve a task.
Responsible	*With Judgement* / *Discretion* / *Responsible* / *Rectitude* Reflect on conditions and concerns, then acting according to what is appropriate to the situation. Making responsible assessments and taking actions using professional knowledge, experience, understanding and common sense. E.g., Responsibility, Professional astuteness.
Adaptable	*Adaptable* / *Flexible* / *Agile* Ability or willingness to adjust approach in response to changing conditions or needs.
Collaborative	*Collaborative* / *Team Player* / *Influencing* Willingness to work with others, engaging appropriate involvement of other persons and organizations helpful to the task. Striving to be respectful and productive in achieving a common goal.
Responsive	*Responsive* / *Respectful* Reacting quickly and positively. Respecting the timing needs for communication and actions needed to achieve the goals of the work.
Meticulous	*Attentive to Detail* Achieves thoroughness and accuracy when accomplishing a task through concern for relevant details.
Inventive	*Exploratory / Inventive* Looking beyond simple solutions. Examining alternative ideas and solutions; seeks, produces, and integrates appropriate alternatives.

Table 5: Prospective Dispositions Summarized in The CC2020 Report (Clear & Parrish et al., 2020)