Volume 13, No. 4
July 2015
ISSN: 1545-679X

Information Systems Education Journal

In this issue:

The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **EDSIG**, the Education Special Interest Group of AITP, the Association of Information Technology Professionals (Chicago, Illinois). Publishing frequency is six times per year. The first year of publication is 2003.

ISEDJ is published online (http://isedjorg). Our sister publication, the Proceedings of EDSIG (http://www.edsigcon.org) features all papers, panels, workshops, and presentations from the conference.

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INFORMATION SYSTEMS EDUCATION JOURNAL

An IT Strategy Course: Why and How

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Abstract

With continuing changes in all aspects of the technology field, especially the emergence of cloud and "as a service" offerings, developing skills for strategic thinking about technology is of increasing importance to our students. However, the presence of formal IS/IT strategy courses in programs of study trails that of more traditional courses. In addition, there is limited discussion on the teaching of strategy in the academic literature. This work offers reasons for the continued importance of teaching strategy and provides examples of how strategy is covered in a course on Global and Strategic Issues in IT.

Keywords: IT Strategy, Active Learning, Experiential Learning, IS Curriculum, Pedagogy

1. INTRODUCTION

The topic of strategy is explicitly included in the IS 2010 curriculum (IS 2010) through the IS 2010.7 IS Strategy, Management, and Acquisition course that is recommended for all IS Majors and Minors. Core elements of strategy are also related to several of the pervasive themes of "user centeredness and advocacy," "professionalism (life-long learning, professional development, ethics, responsibility)," and "interpersonal skills" mentioned in the IT 2008 curriculum (Information Technology 2008).

Despite this, several recent reviews IS programs have found a limited presence of strategy courses in these programs. Additionally, a review of the published literature found few examples discussing how strategy is being taught in IS and IT programs.

The emergence of technologies such as, Software as a Service, Infrastructure as a Service, Platform as a Service, and big data allows IS/IT departments new opportunities for growth. Effectively using these new technologies requires a focus on strategic thinking. We will share an overview of the design of our course, Global and Strategic Issues in IT, as well as specific activities and assignments intended to encourage strategic thinking.

2. STRATEGY IN THE CURRICULUM

The IS 2010 curriculum includes IS 2010.7, IS Strategy, Management, and Acquisition as one of seven suggested core courses. The high level course description provided for IS 2010.7 mentions several topics related to strategy including "IS strategic alignment," "strategic use of information," "IS Planning," and "Using IS/IT governance frameworks." IS 2010.7 is one of three courses recommended for all IS majors and minors.

While the IT 2008 curriculum does not include a specific strategy course, strategy would fit in the IT Capstone courses described in the Integration-First Approach or the Social and Professional Issues in IT course from the Pillars-First Approach (Information Technology 2008).

The IS2010 curriculum was the first major revision in almost 10 years and included significant changes. Given the competing demands on faculty time, it would not be surprising if it took some time for major additions like the IS2010.7 course to make their way into programs of study.

A review (Apigan & Gambill, 2010) of programs at 240 colleges and universities assessed these programs in view of the IS 2009 working model curriculum. This review found the IS2009.7, IS Strategy, Management, and Acquisition course in only 35.4% of the programs reviewed. Of the seven core courses in the curriculum, the only course found in fewer programs was IS 2009.3, Enterprise Architecture, which was present in 20.6% of the programs. For comparison, the IS2009.4 IS Project Management course was found in 53.8% of the programs studied, and the remaining IS2009 core courses were found in at least 83% of programs.

Studies of the final IS 2010 curriculum find similar results. A study of 127 AACSB accredited undergraduate programs (Bell, Mills, & Fadel, 2013) found the core IS 2010.7, IS Strategy, Management, and Acquisition course in only 29 % of programs. Again, only IS 2010.3, Enterprise Architecture, was found in fewer programs (17 %). On the other hand, four of the core courses were found in at least 70 % of the programs.

A study reviewing the presence of IT 2010 curriculum elements in 37 ABET accredited programs (Feinstein, Longenecker, & Shrestha, 2013) found the IS 2010.7 and IS 2010.3 courses were found in only 10 of the 37 programs reviewed.

While the data shows a limited presence of courses matching the IS 2010.7 IS Strategy, Management and Acquisition course, this doesn't exclude that potential that topics related to IS strategy may be covered in other courses.

3. WHY TEACH STRATEGY?

To frame this discussion, a definition of strategy is useful. For our purposes, we define strategy as the efforts related to developing a high level plan to achieve goals in an uncertain environment. For the IS/IT field, strategy must be discussed in terms of supporting the overall strategy of a business or other organization.

This definition of strategy is in agreement with several of the guiding assumptions of the IS 2010 curriculum, which include that "students must therefore understand that:

- Information systems in organizations have increasing strategic significance ..." (IS 2010, p. 8)
  and
- "Focus on the application of information technology in helping individuals, groups, and organizations achieve their goals within a competitive global environment. " (IS 2010, p. 8)

In addition to its inclusion in the IS 2010 curriculum, there is other evidence of the importance of strategy in the IT field from discussions about the role of the Chief Information Officer (CIO). Gefen et al. (Gefen, et al. 2011) report on a CIO roundtable discussion and note "a shift in the role of the CIO from IT service provider to business integrator" along with other observations that indicate an increasing need for strategic skills.

Discussions on the role of the CIO can also be found in higher education. Voss and Wheeler (Voss & Wheeler, 2010) initiated a debate framed around the concept of "CIO as plumber" with a focus on operational aspects of technology and "CIO as strategist" with a focus on the use of technology to achieve an institution's strategic goals. As this discussion has evolved (Voss, 2014a; Voss 2014b), the value of both roles has been acknowledged. Also mentioned

> "pressure on our profession to separate into two or more parts: the part that keeps the lights shining and things in compliance; and the other parts that direct another type of light (information technology) into new places to address the disruption and enable the transformation." (Voss, 2014a, para 9)

Clear risks are seen in fragmenting the CIO role, reinforcing the need for IS/IT professionals to be able to think and act strategically.
Another consideration in developing skills related to strategy is that students can apply the same skills to career planning, lifelong learning, and professional development since all of these involve planning for achieving a goal in an uncertain environment.

4. AN OVERVIEW OF THE COURSE

In the Computer and Information Technology Department at Miami University, students have the opportunity to learn about strategy in a 400 level course addressing Global and Strategic Issues in IT (see appendix for an outline of the course). In this course, students learn how to identify and adapt to the cultural differences found in today's world. There is specific emphasis on understanding how technology is used in different parts of the world, and developing the skills needed to understand, assess, and make informed decisions about global technology issues. The course satisfies a Miami University Liberal Education requirement in the Global Perspectives category, which requires that courses be designed "to have a global perspective and help students develop the ability to communicate and act respectfully across linguistic and cultural differences." (Miami Global Perspectives, n.d.)

As previously described in more detail (Howard et al., 2012; Howard & Petrone, 2010), we designed the course around Bloom's learning domains: *Cognitive* through lectures and reading; *Affective* through reflections and discussions, and *Psychomotor* through simulations, activities, and applications to the students' own work (Bloom et al, 1956). Toward the end of the semester the activities and assignments encompass a synergy of all three domains. For the first third of the course, students research and participate in activities that facilitate learning about their own cultural orientation, the culture of specific USA-based technology corporations, the culture of the USA, USA demographics, and the IT Infrastructure of the USA. During the last two-thirds of the course, each team of students studies three countries: one of the BRICI countries (Brazil, Russia, China, India, Indonesia) because of their importance as emerging world economies as well as two other countries. The teams begin by researching the culture and demographics, and then move on to the many aspects of the IT infrastructure covered in the course.

For strategy, the main skills that students develop are the collecting and analyzing of data to develop recommendations. An important part of this involves learning about useful sources of strategic information about technology. Fortunately, there are a number of strong resources, starting with strategy consultancies. Gartner (www.gartner.com) and McKinsey (www.mckinsey.com) both offer some information with a free registration. Additional information is available to clients – check with your school's Information Technology group to see if they are clients of Gartner or McKinsey. Educause (www.educause.edu) provides information specific to technology use in higher education to members, which includes many higher education institutions. Local CIOs and senior IT leaders are also good sources for ideas on emerging technologies and strategic IT topics.

Additional discussion of strategic issues in information technology can be found in the information technology trade press, including *Information Week* (www.informationweek.com) and *CIO* (www.cio.com) magazine. More general business oriented publications such as the *Economist* (www.economist.com) also offer detailed analysis of the impact of technology on business. A good source of discussion topics are annual top-10 lists that can be found in several sources. Two good sources are the annual Educause Top-10 list (Grajek, et al., 2014) and the NMC Horizon Report for Higher Education (Johnson, et al., 2014) which are focused on technology in higher education and are likely to cover technologies with which students are more familiar.

Throughout the semester, classroom activities introduce students to specific topics related to global, cultural, and strategic issues in IT. Activities related to strategy reinforce the need to relate the use of technology to meeting the strategic goals of an organization or business. Emphasis is also given to having students develop skills for keeping up to date on emerging technologies and finding information about the use of technology in a specific industry.

Teams of students work together to apply the skills learned in class to collect and analyze data for presentations on a series of increasingly complex questions about the countries that they are studying. This leads to a final presentation where each team presents three ideas for potential IT projects to a hypothetical USA based technology company. Each of these IT projects are located in the countries that the teams have been studying. Each team also recommends one of their IT projects by building a business case to support their recommendation.

5. IT STRATEGY CLASSROOM ACTIVITIES

To help readers gain a better understanding of the strategy focused course activities, detailed descriptions for several activities are provided.

Hype Cycles ("Hype Cycle Research," n.d.) are one of Gartner's research methodologies related to the life cycle of a technology or technologies in a specific field. Figure 1 shows a generic Gartner hype cycle showing the expected changes in a technology's visibility as the technology matures. In class, students review Gartner's article explaining the Hype Cycle (Fenn & Raskino, 2013). Students then review recent hype cycle publications and select one for detailed review. While reviewing the selected hype cycle, each student generates one question or observation to be shared during small group discussions.

A similar activity is used for students to learn about the Gartner Magic Quadrant ("Magic Quadrant Research," n.d.) methodology. Figure 2 shows a generic Gartner Magic Quadrant showing how technology providers within a specific area can be viewed in terms of their vision and ability to execute. Again, students review the details of Gartner's methodology (Black & Thomas, 2013) and then select a specific MagicQuadrant for in depth review and discussion.

In addition to learning about tools, students are also introduced to new or emerging technologies and asked to think strategically about the impact of the technology. Guided class discussions are held around many technology topics. For example, for disaster recovery, students read an article about a fire at Notre Dame (Latimer, 2009). Teams of students then brainstorm on the different technology systems at the university and the list is merged from all of the teams. Once a list has been created, teams choose the five technologies that they think should have the highest priority to be restored. Teams are then merged and asked to take both lists of their top five and merge them into a single list of five. Finally, teams report to the entire class and the entire class joins in a discussion about the priorities.

For cloud computing, students are presented an overview and then work in small groups to identify examples of cloud computing, how cloud computing could help a business achieve strategic goals, and potential concerns from an IT perspective. The entire class then shares and discusses the items identified by the small groups. As part of this discussion, the university's selection and implementation of Google Apps for Education was used to support a specific discussion of interesting points.

For big data, before class, students read an overview on big data (Cuiker, 2010) that is then discussed in class. Students are presented a brief overview of big data and watch and discuss short videos identifying strategic and technology considerations related to big data. Students also complete a hands on activity (adapted from Frydenberg, 2013) using Google's BigQuery tool to get a feel for working with big data. This was followed by small group discussions with the same questions as the cloud computing exercise.

A final in-class activity focuses on gathering and analyzing information about high level strategic trends in the IT industry. For this exercise, students read a summary of a McKinsey survey on business and technology strategy (Khan & Sikes, 2014). The summary includes focused discussions on seven specific areas. Three of these (use of IT to improve business effectiveness, breakdown of planned future IT spend, and anticipated talent needs) are used for small group discussion activities. Each group reviews the assigned section and responds to discussion questions. The small group discussions are then summarized for the entire class.

6. CONCLUSION

While technical skills remain important in the IT and IS fields, technology departments continue to shift the emphasis on IT infrastructure to analytics and innovation to improve business efficiency and effectiveness (Khan & Sikes, 2014). Our students not only need technology skills but they also need to understand how that technology can benefit their organization. Our course, Global and Strategic Issues in IT, combines intercultural, global, and technology topics that help foster strategic thinking.

Evidence of student achievement of strategy related learning outcomes can be found in reviewing the group presentations throughout the course. As the course progresses, these show steadily increasing to strategic aspects of the use of IT. For most groups, the final presentation offering three foreign expansion ideas for a USA technology company to consider show the expected consideration of intercultural, global, and strategic issues.

7. FUTURE PLANS

For the strategy activities a few improvements are being considered. The activities that introduce the Gartner Hype Cycle and MagicQuadrant tools could be put in context for the higher education environment. Students could use an education related Hype Cycle and assess the university's current efforts on the technologies covered in the Hype Cycle. Similarly, a relevant MagicQuadrant could be identified and assessed in a local context. Both activities could also be extended to include a discussion with the university CIO.

To reinforce the point that IT strategic activities need to work in support of the larger business or organization, students could review the overall university strategic plan and IT specific strategic plan. Students could assess how well the IT plan is tied to higher level goals in the university plan. This would be another opportunity for a discussion with the university CIO or other senior IT staff involved with strategy development.

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Editor’s Note:

This paper was selected for inclusion in the journal as the ISECON 2014 Best Paper The acceptance rate is typically 2% 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 2014.

Appendices

Course Overview and Major Student Assignments

Week	Class Activity	Major Student Assignments (listed when they are due)
1	Intro to Course and Global Perspectives	
2	Exploring Culture	
3	Working with Americans	Cultural Assessments
4	Global IT Challenges	Know your Company
5	Tracking Emerging Technologies	
6	Intellectual Property Rights	Know Your Country
7	Security and Privacy	Country Profile #1
8	Technology Management and Disaster Recovery	
9	e-Commerce	Country Profile #2
10	IT Industry and Mobile Computing	
11	IT Industry	Country Profile #3
12	The Cloud and BIG Data	
13	3D-printing and other technologies	
14	Final Presentations	Comfort Zone Assignment Final Project

The course also includes a number of other smaller scale assignments to help students learn about and reflect on global cultural and technology topics.

Know Your Company – Students work in small groups to learn about a specific US technology company. Students work to learn about the company from the perspective of a global IT professional. Groups explore their assigned company's mission, values, global presence, approach to cultural differences, etc. to form a perception of the company. Group findings are shared in a 15 minute in-class presentation.

Know Your Country – Students work in small groups to develop a reference handbook and presentation for a non-US technology company that is looking to expand into the USA.

Country Profiles – Students work in small groups to develop and present a series of country profiles.

1. Provide an overall introduction to the group's primary country (typically a BRICI country), including demographics, government, cultural dimensions, economics, and assessing how well the group's company (from the Know Your Company assignment) would fit in the country from a cultural perspective.
2. Provide an introduction to a secondary country assigned by the instructor and overview of IT infrastructure for the group's primary country.
3. Provide an introduction to a third country (chosen by the group and approved by the instructor) and also profile the IT Industry, mobile computing and the Cloud in the group's primary country.

Comfort Zone Assignment – Students reflect on their comfort zone and identify a culture about which they know little. Each student identifies an activity that will take them out of their comfort zone and writes a 1 – 2 paragraph description for the instructor to review and approve. Students then complete the activity and use techniques learned in class to observe and reflect on the experience and write a 1 – 2 page paper about the activity and what they learned from stepping outside of their comfort zone.

Final Project - For the final project, the student groups are working as consultants for a hypothetical US based technology company. The students identify three potential IT projects in one of the countries the group has researched for the Country Profiles. On the last day of class, each group turns in a business case document discussing the three potential projects including technical and cultural challenges and making a final recommendation. The groups also make an executive level presentation on the projects and final recommendation.

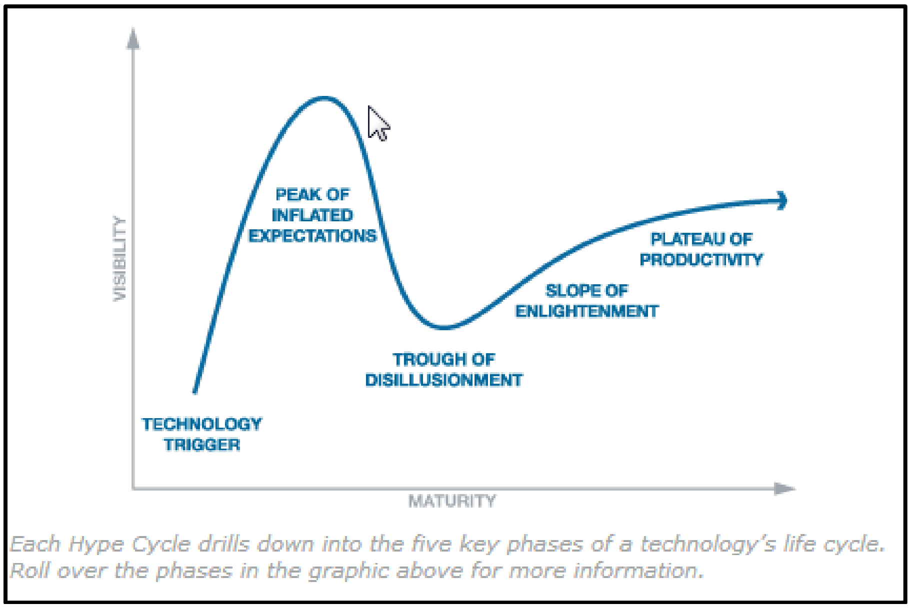

Figure 1. The Gartner Hype Cycle methodology for viewing technology's life cycle.

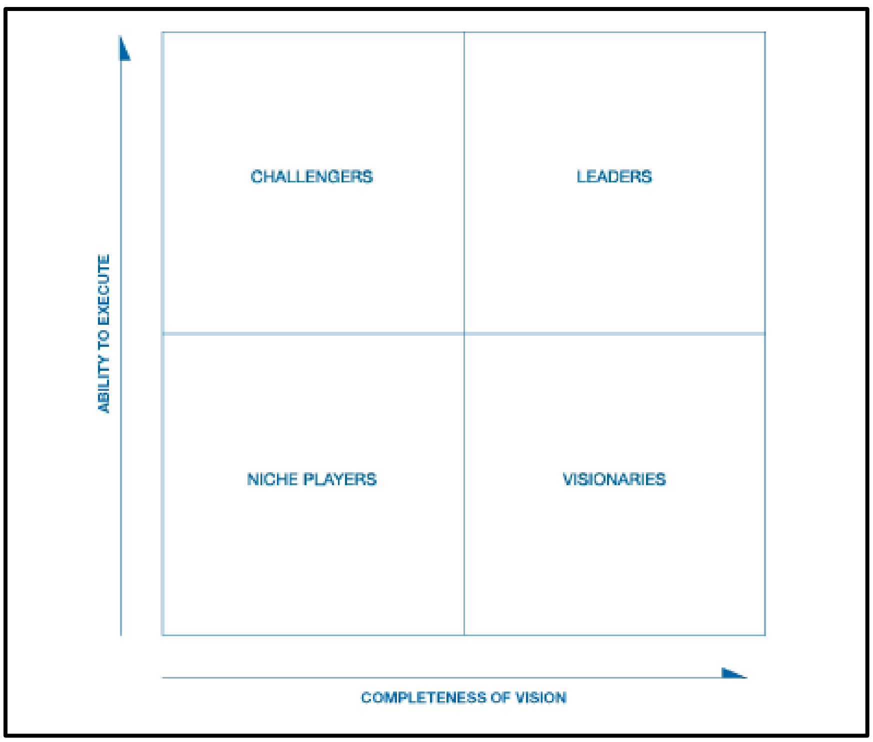

Figure 2. The Gartner Magic Quadrant methodology for understanding technology providers in a specific technology area.

Live, Model, Learn: Experiencing Information Systems Requirements through Simulation

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Abstract

Information system professionals strive to determine requirements by interviewing clients, observing activities at the client's site, and studying existing system documentation. Still this often leads to vague and inaccurate requirements documentation. When teaching the skills needed to determine requirements, it is important to recreate a realistic environment to develop analytical thinking skills. To address this, we developed a simulation for students to learn requirements gathering and analysis where they experience the requirements by operating a fictitious manufacturing firm. The students manage and operate the company, taking on a variety of employee roles from the physical "manufacturing" to the order-taking to the purchasing of component parts. With this pedagogical approach, students deal with the messiness of the problem by drawing on their own experience working in the manufacturing firm, making assumptions, and having the opportunity to verify their assumptions and analyses by working with their classmates. The simulation was implemented across two courses in an undergraduate information systems program.

Keywords: simulation, requirements determination, pedagogy, modeling, active learning

1. INTRODUCTION

Requirements determination and documentation of business needs through modeling techniques, such as data flow, entity relationship, and UML diagrams, are critical skills for information system (IS) practitioners. In the field, a systems analyst or project team will determine requirements by interviewing clients and users, observing activities at the client's site, and studying existing system documentation. Often the information initially provided by the client is incomplete, not 100% accurate, and presented in an illogical sequence. If the analyst or project team fails to identify the missing and/or misrepresented needs of the client, the system will be flawed at implementation, as it will not be aligned with the true requirements and business needs. This potentially leads to failure of expectations and wasted resources.

One objective in teaching requirements determination and analysis is creating a problem domain that students can comprehend with a level of complexity that is neither too simple to present a genuine challenge nor too difficult to understand and model. The effort of creating effective learning material is amplified given the background of students varies both within and across universities. Some textbook scenarios, case studies, and assignments that are used to educate and train IS undergraduate students describe the problem domain by providing a list of requirements. These lists come in a variety of forms, such as bulleted lists, paragraphs, and videos. This effectively provides students with an opportunity to practice the syntax of the specified modeling approach, but the opportunity to actually analyze the business situation is limited.

When students find, however, that the exercises are too vague or complicated, due to their limited business background, students may perceive there is no mechanism to clarify their own assumptions, making them hesitant to state those assumptions, draw models, and formulate decisions based on the information provided. When the students find the exercises are too neatly packaged or too simple, the modeling exercises may become overly repetitive and routine as it is not necessary for students to make their own assumptions or draw conclusions. Understanding when one needs to make an assumption, making the assumption, and determining how to verify its appropriateness are critical skills to develop as part of requirements determination. When using traditional textbook exercises, it is difficult to create realistic experiences for students because static text is not interactive and cannot respond to specific questions as they emerge during the problem-solving phase of the exercise. To be successful in the information systems profession, a systems analyst must be able to identify the weaknesses inherent in information provided, analyze the situation, and devise a strategy to elicit the true requirements. This involves walking a fine line between both gathering information and questioning it at the same time.

To better prepare students for the industry, we developed an in-class simulation that provides students with exposure to a requirements determination process that incorporates vagueness, incomplete information, and the opportunity to acquire incorrect information and/or perspectives. This, as a result, forces students to make assumptions and seek to verify them, bringing together the gathering and questioning of information. We sought to create an experience where students would be motivated to dive into the messiness of the problem in an environment where information gathering and requirements development would be required before modeling, instead of having requirements simply listed. With this pedagogical approach, students deal with the messiness of the problem by drawing on their own experience working in a manufacturing firm, making assumptions, and verifying their assumptions and analyses by working with their classmates. The following sections of this paper describe prior literature, this didactic approach, and the implementation of the approach.

2. LITERATURE REVIEW

Requirements Determination

Requirements determination starts with the scope statement and leads to a list of specific functional and non-functional requirements that must be met to create the deliverable described in the scope statements (Dennis et al., 2012). Also called requirements discovery, requirements determination is a process of fact finding where a variety of tools and techniques can be used, such as stakeholder interviews, observation and document analysis (Whitten and Bentley, 2007). By studying existing procedures, reports and forms, an analyst can uncover both problems with the existing system and also opportunities to enhance system capabilities in a new system (Hoffer et al., 2014). Studies have shown that a flaw found in a system after it has been released to users can cost from 10 to 100 times more than if it had been identified and resolved when the requirements were being determined (McConnell, 2004). This suggests that learning how to determine system requirements is a critical component in educating information systems students, and successful learning activities may lead to improved systems quality and reduced costs.

Although there is substantial research on requirements elicitation, knowledge acquisition and requirements analysis (Byrd et al., 1992), little research is available on the pedagogy of preparing a student to know to apply the theory they have learned in the classroom (Hanchey, 2002). Prototyping tools are one technology that has been used in the classroom to develop students' requirements determination skills. Dalal (2012) used "rapid game prototyping" in an assignment requiring students to build a game using one of their personal friends or a family member to provide the game requirements.

Inquiry-Based Learning

Another successful approach is inquiry-based learning, which is a student centered approach to learning where, given a scenario or goal, the student acts as a detective, asking questions and performing research (Hu et al., 2008). It has been demonstrated that inquiry-based learning not only contributes to improved learning in specific contexts, but it is also associated with intellectual development (Hu et al., 2008). Simulations present the opportunity for inquiry-based learning as participants interact and explore possibilities. Using simulations in the classroom is an instructional strategy where students are engaged in the discovery of knowledge rather than the recipient of static information (Queen, 1984). A simulation is a model of a real-world phenomenon. As such, the simulation is an abstraction or simplification of the real thing that includes only the aspects of the target necessary to achieve the learning goals.

Simulation Types

There are four types of educational simulations: physical, iterative, procedural, and situational (Lunce, 2006). In a physical simulation, a student has the opportunity to change a system characteristic, such as level of production or routing pattern, and then watch the result. In the iterative simulation, a student develops hypotheses regarding a system parameter, and then observes the results after altering the parameter to test the various hypotheses. The results are observed and then the alteration-observation pattern is repeated until the learner develops a thorough understanding of how the altered parameter affects the construct of interest. In a procedural simulation, a student learns how to operate by observing processes and steps, such as a flight simulator. Finally, a situational simulation involves a goal-directed, role-playing exercises.

Furthermore, simulations can be individual or group activities. Studies have shown that groups consistently outperform individuals in many types of activities, and team-based projects in academic settings, such as information systems courses, lend themselves well to a constructivist approach to learning (Keys, 2003; Derrick & Haggerty, 2001; Cronan & Douglas, 2012). The group simulation provides a shared experience for the participants, and both common intellectual experiences and collaborative projects are considered high-impact educational practices (Kuh, 2008).

Classroom Simulations and Active Learning

Classroom simulations require active student involvement, which leads to a deeper understanding of the issues (Montgomery et al., 1997). Active learning, experiential learning, and constructivism are essentially synonymous terms for a student learning by doing or engaging. Kolb (1984) described experiential learning theory as "a holistic integrative perspective on learning that combines experience, perception, and behavior." Thus learning is not viewed as a final state where knowledge has been acquired; rather it is viewed as a process where the learner interacts with the environment. On the other hand, in the traditional classroom lecture, an instructivistic approach, the student is viewed as a passive receptacle. Leemkuil et al. (2003) describe instructivism as "characterized by the explicit presentation of non-arbitrary relationships between pieces of information to learners" (p. 100). Thus the lecture may be an effective way for a student to acquire knowledge of facts and procedures. Lectures alone, however, fail to communicate how challenging it is to apply that knowledge in a professional setting (Jeffries, 2005). This suggests that utilizing multiple educational strategies can be useful in the classroom.

Studies across disciplines consistently find that experiential learning is deeper and more enduring than the rote memorization, which often accompanies the classroom lecture. Kolb (1984) identified four specific stages learners proceed through to develop understanding: 1-concrete experience, 2-reflective observation, 3-abstract conceptualization, and 4-active experimentation. In other words, Kolb said the learner must interact with the learning target, think about the experience, generalize their understanding of the experience, and then test their generalized theory. Montgomery et al. (1997) applied Kolb's four step experiential learning process in an introductory education class. To gain concrete experience, the students attended a local school board meeting. Then the students engaged in reflective observation by discussing their experience in the classroom. The third phase, abstract conceptualization, required students to assume the role of a board member and "prepare for the simulation through researching the stakeholder's role and writing a grant proposal to present during the simulation" (p. 223). They found that because the students participated in the simulated board meeting, they had a deep understanding of the responsibility and influence of the U.S. educational system. Leemkuil et al. (2003) used a physical simulation to train people in the area of knowledge management, and demonstrated the importance of both providing domain instruction to prepare students for the simulation and also debriefing the students afterwards. These finding are consistent with Kolb's four abilities model.

The nursing education literature also suggests that educational simulations, particularly physical clinical simulations, lead to longer retention of knowledge, development of skills that are directly applicable in patient care, and increased confidence (Jeffries, 2005). Simulations are commonly used in business schools, particularly in operations and supply chain management. Perhaps the most well recognized supply-chain simulation is the "Beer Game," a physical simulation, which was developed at MIT. The game demonstrates how small changes in downstream demand (e.g. consumer purchases) can lead to big changes in upstream order quantities (e.g. manufacturer / work orders), a phenomenon call the bullwhip effect. What is compelling about the "Beer Game" is how clearly participants can see the bullwhip effect and that the manifestation of the bullwhip effect occurs regardless of who is participating (Goodwin & Franking, 1994). Klassen and Willoughby (2003) developed a similar simulation, but their version included the costs associated with over-ordering and shortages. They found that those participating in the simulation not only increased their general knowledge of inventory management, but also gained an appreciation for the complexity of the problem. Bandy (2005) also used an in-class simulation to demonstrate the benefits of pooling safety stock across decentralized locations. Subsequent student performance on a quiz and the results of a survey given to the students after the simulation both indicated that the simulation was instrumental in students understanding the benefits of pooling safety stock.

Engaging students in an active learning process by employing a physical simulation creates an opportunity for greater understanding of the theory taught in the classroom. This technique can enable students to better understand how to effectively discover the needs of the client and develop better solutions to the business problems.

3. PEDAGOGICAL APPROACH

To encourage inquiry-based and active learning in a group experience, a simulation was developed situated around a company called Fetch, Inc., a fictional manufacturing firm. This is a physical simulation where the students manipulate production levels and the purchasing pattern of raw goods inventory. To develop a learning experience where the learner interacts with the environment, it was required to create such an environment.

To understand and gather the requirements, the students manage and operate the company, taking on a variety of employee roles from the physical "manufacturing" to order taking to purchasing of component parts. While working at Fetch, students experience the manufacturing process grind to a halt as component parts become unavailable, which is based on their chosen production levels and purchasing patterns. Neither management nor the purchasing department is in a position to correct the problem, because they are all working with bad information, whether it is stale or simply inaccurate. The experience of working at Fetch provides students with both a low-level detailed experience based on their role and a high-level overview of how the departments operate and experience failure. To control the complexity of the simulation, we opted to not include any financial information. The key focus is on inventory quantities as accurate inventory management is necessary for consistent, timely production of finished goods.

Although the context of this simulation is operations management, the learning objective is not related to operations management. Our objective is to develop and refine requirements determination and modeling skills. All information systems projects are embedded in some business context. We chose the manufacturing context because we were able to model the business context using tinker toys. We believe this physical simulation made the business context more understandable to the students in comparison to other less tangible contexts, like accounting or marketing.

Throughout the remainder of the semester, students model the processes they experienced in the simulation, identify the problems and requirements necessary to fix the problems, and model the solution that can be supported by a new information system. With this didactic approach, students deal with the messiness of the problem by drawing on their own experience working at Fetch, review the documentation generated during the simulation, make assumptions, and have the opportunity to verify their assumptions and analyses by working with other Fetch employees - their classmates.

Simulation Administrative Details

The simulation takes approximately 1 hour to conduct. However, the students utilize the experience gained during the 1 hour for many weeks in the semester, including during class, group meetings, and the creation of deliverables. For the simulation, students are assigned roles in one of the various departments and issued job descriptions, which included what their responsibilities are and any artifacts needed to complete their work. These departments are: manufacturing, quality control, shipping, order entry, operations management, purchasing, and general management. Four to six students are assigned to manufacturing, shipping, order entry, and purchasing. One to two students are assigned to quality control, operations management, and general management. In addition to the instructor and students, the simulation requires two additional assistants to run. One assistant is responsible for feeding orders (via dropping paper slips in an inbox) to the order entry department, and the other assistant is responsible for receiving and fulfilling orders placed by the purchasing department. In order to fulfill the orders for component parts, this second assistant should also accumulate product shipped by Fetch so that he/she can disassemble them and use those pieces for fulfillment. It is recommended that this person has a station external to the main simulation room. See Appendix A for other steps necessary to conduct the simulation.

Supporting Materials

Over twenty artifacts were developed to support the operation of Fetch, Inc., including job descriptions for each role, forms, and report templates. These are available by request from the authors. For example, Appendix B describes the procedures that the purchase order clerk is to follow, which is included in the job description for the role. In order to complete these instructions, the Purchase Order (PO) clerk needs to work with the following documents: Reorder Point Memo, Raw Goods Inventory on Hand Report., Suppliers List, Price List, Purchase Orders, and the Purchase Order Ledger. Each of these was prepared prior to the simulation.

Simulation Execution

The “manufacturing” was performed by students in the role of shop floor employee. Students “built” products using Tinker Toys as raw materials and a bill of materials that described the component parts and assembly of each product (see Figure 1 for sample portion of the BOM). The simulation was driven by fictional email messages containing customer orders. The operations of the company includes everything from recording customer orders, manufacturing products, purchasing raw materials, building, inspecting, and shipping products. Communication regarding work performed is conducted within and across departments using the forms and report templates provided for the department. Departments can send these forms, as specified in the instructions, to each other using the department mailboxes.

The work procedures given to the participants are logically sound. The overlapping and loosely coordinated activities of the functional areas, however, inevitably lead to a work stoppage as raw materials are consumed, not adequately replaced, and customer orders consequently cannot be manufactured and shipped. Thus, within one hour of "operating" Fetch, the system breaks down.

Portable Scanner 1 Red Bulb 1 Pink Clip 1 Green Flipper 1 Orange Rod 1 8 Hole Disk		First join the Orange Rod with 8 Hole Disk. Be sure to secure firmly. Then attach the other end of the Orange Rod to its …

Figure 1. Excerpt from Bill of Materials

Debriefing and Classroom Application

At the end of the simulation, the number of orders and the order metrics (customer orders, work orders, purchase orders and open, closed, waiting to ship orders) are counted as a mechanism for measuring performance of the session. Immediately following the simulation, a debrief should be held to elicit ideas from the students as to why the system breaks and what can be done to fix it. The order metrics are also presented at the debrief. The specific cause of the failure and subsequent low metrics is a delay in communicating both the consumption of raw material and the shipment of finished goods inventory – an information problem. In other words, demand is realized too late in the process. It is the system's failure that becomes the main focus of the exercises and assignments following the simulation. Throughout the remainder of the semester, students create diagrams modeling the user requirements, data structures, and processes for an information system that could correct the inherent data timing and quality problems in the operations of Fetch, Inc. To create these models, students use their own simulation experience, interview their classmates, and study documentation and forms used in the simulation. See Appendix A for a listing of the forms and reports used in the simulation.

4. IMPLEMENTATION OF THE PEDAGOGY

The pedagogical approach was implemented across two courses, bringing together related concepts from a Systems Analysis and Design course and a Data and Information Management course. These two courses are the first two taken by Information Systems Management majors in the Palumbo-Donahue School of Business at Duquesne University. As these courses are typically taken by first semester juniors, 85 to 90 percent of the students are registered in both courses simultaneously. This implementation was innovative in its own right because it allowed the instructors to demonstrate cross-course concepts - determining and documenting requirements to serve as the basis for information system design. This process is a critical skill for students studying information systems and is directly related to both courses. The Systems Analysis and Design course focuses on how to determine the requirements of an application (e.g., what actions must be accomplished by the users of the system), while Data and Information Management course focuses on the requirements for data storage (e.g., what information needs to be stored and accessed). Further, both courses provide students with skills necessary for creating diagrams and other artifacts to document requirements using industry-standard modeling methodologies. The simulation could be used in either course independently, however.

Prior to the day of the simulation, students were briefed in the classroom to ensure their familiarity with the business context. The briefing reviewed a manufacture-to-stock scenario where (1) customer orders deplete finished good inventory, (2) a reduction in finished goods triggers work orders to manufacture more product, (3) the manufacturing process consumes raw goods inventory, (4) and reductions in raw goods triggers purchase orders for the component parts. Industry-standard modeling methodologies are covered throughout the courses.

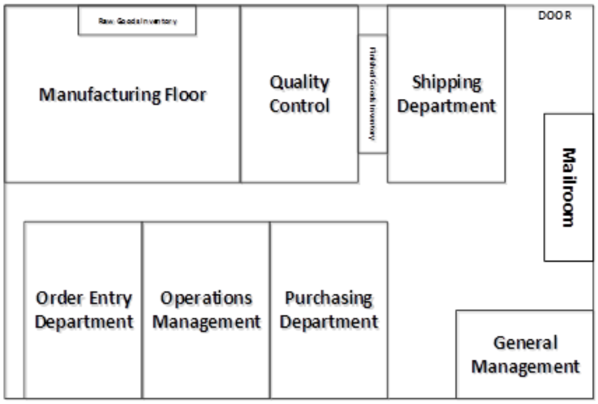

Figure 2. Plant Layout

In order to conduct the simulation in a classroom, the room was transformed into a "plant layout". The classroom furniture was arranged in a way that suggested there were seven different work areas (see Figure 2). Each area or department had a sign indicating the function performed there. Products in different stages of production were placed at different work areas to create the illusion of on-going operations at the start of the simulation.

5. Analysis

96 students participated in the simulation and were assigned to one of 4 sessions. Within 30 to 40 minutes, each of the sessions led to a system breakdown, as predicted. The order metrics (customer orders, work orders, purchase orders and open, closed, waiting to ship) were collected for each session (see Table 1).

	Cos			WOs		POs	
Session	**C**	**O**	**W**	**C**	**O**	**C**	**O**
A	8	7	2	4	10	10	6
B	8	5	7	7	10	5	3
C	6	7	8	8	11	10	7
D	4	5	8	8	6	12	0
C-closed, O-opened, W-waiting to ship							

Table 1. Final Order Statistics

Debriefing

The class session after the simulation, the students were debriefed on their experience. They were asked:

- With all the open orders and work-in-process, why weren't you, as employees, working?
- Why was everyone sitting around waiting when customers weren't receiving the products they ordered?

Listening to the students responses, it was clear to the them that (1) the shipping department was not shipping because the ordered parts were not in inventory, (2) the shop floor was not working because the component parts were not available in the raw goods inventory, and (3) the purchasing department was not ordering because the shop floor did not report the use of raw goods until after the work on the customer's order was done. At this point it was clear to all that the movement of parts needed to be reported as soon as the parts were pulled out of inventory. Carrying excess inventory would hide this problem, but not solve it. Better inventory practices such as just-in-time or lean would only exacerbate the problem. The above issues were independent of who was participating. They occurred in every session of the simulation.

There were additional problems that occurred as individuals made adjustments to the procedures to solve local issues without knowledge of how it would affect the overall process. For example, one of the purchasing clerks decided to order larger quantities of all parts so the shop floor would have everything they needed. The student was unaware that the availability of component parts was limited (this is realistic – scarcity or lead-time issues), and an assistant who helped run the simulation by receiving newly shipped customer orders was instructed not to "ship" partial orders for component parts (realistic – shipping costs). What physically happened was that the shop floor was waiting for component parts to enter raw goods inventory to finish building the product. New pieces, however, could only be made available when the assistant received finished products and could disassemble them to fill orders for component parts. No orders were leaving the plant because they were waiting on component parts. No parts were entering the plant because the assistant was waiting to disassemble shipped finish products, which would not be available because they were stalled in the manufacturing process.

Attitudinal Survey
An attitudinal survey was administered after the simulation was complete, but prior to the debriefing. Seven questions were used to assess the students' impressions of the simulation (see Appendix C) with a 7-point Likert scale from strongly disagree to strongly agree. Three areas were addressed. One, they were asked about the relative learning productivity of the simulation and should it be used again. Two, they were asked which was more enjoyable – the simulation or traditional lectures. Third, they were asked if they better understood the effort required to effectively work in teams.

We discarded 6 of the 96 participants responses because they answered both questions on enjoyment with the same response, and one item was reverse coded (response was not "4 = Neither Agree nor Disagree" in any of these cases). The results showed that no more than four students (out of the 90) responded negatively to the learning effectiveness or enjoyment of the activity. Over 84% of the respondents reported a greater appreciation for working in teams. Lastly, only two respondents would recommend we not use the simulation again.

Post-simulation Learning Goals
In addition to the one-hour simulation and the briefing and debriefing, students were given access to all the supporting documentation which includes job descriptions, work procedures, forms, report formats, and students were encouraged to interview one another about their experience and understanding of Fetch's operations. Thus the process of discovering and analyzing requirements continued throughout the remainder of the 15 week course.

The purpose of the simulation was to create an experience where students understood the complexity surrounding requirements determination and documentation; the purpose of the assignments was for the students to apply that understanding and for the instructors to assess the learning outcomes. Specific learning goals for the courses to measure learning are shown in Table 2.

Learning Goal	**Measure (Evidence)**
Learning Goal 1 (381 W): The student will be able to evaluate the current system and determine the requirements for creating an improved system.	• UML Model assignments • Entity Relationship Model assignments • Data Flow Model assignments • Use Case assignments
Learning Goal 2 (381 W): The student will be able to model system requirements using object-oriented modeling techniques.	• UML Model assignments ○ Functional Models ○ Structural models ○ Behavioral Models
Learning Goal 3 (381 W): The student will be able to model system requirements using process-oriented techniques.	• Process Model assignment • Multi-level Data Flow Diagram
Learning Goal 4 (382): The student will be able to model system requirements using data-oriented modeling techniques.	• Entity Relationship Diagrams incorporated into course project
Learning Goal 5 (382): The student will be able to build a functioning database to support their data model.	• Creation of a functional database using MS SQL Server as part of course project.

Table 2. Learning Goals

For each of the learning goals in Table 2, student assignments completed post-simulation are specified as evidence that they have met the goal. The first three goals are part of the Systems Analysis and Design syllabus, whereas goals four and five are part of the Data and Information Management syllabus. The simulation allows students to experience the system through participation and discussion with classmates, and thus more fully understand the system and its weaknesses, which is strongly aligned to what they would experience in industry. This insight creates a basis on which students can create richer system development artifacts, even though the source of information is less clear than traditional written exercises in textbooks. Further, students are forced to make assumptions and attempt to verify their own assumptions by working with classmates.

Performance on the above assignments/project is the best way to assess student learning as a result of the simulation. Table 3 lists the major assignments/project in the courses, the learning goal(s) that each assignment/project support, and the average grade assigned to deliverable.

Assignment/Project	Avg Score	Learning Goal Supported
Assignment 1:Use Case Modeling	91%	• Learning Goal 1
Assignment 2: Structural Modeling (Class Diagrams)	87%	• Learning Goal 2
Assignment 3: Behavioral Modeling (Sequence Diagrams)	94%	• Learning Goal 2 • Learning Goal 3
Assignment 4: Behavioral Modeling (Sequence Diagrams & State Diagrams); Process Diagrams (Activity Diagrams)	94%	• Learning Goal 2 • Learning Goal 3
Assignment 5: Process Modeling (data flow diagrams to support their data model.	85%	• Learning Goal 3
Database Course Project	94%	• Learning Goal 4 • Learning Goal 5

Table 3. Learning Goals Assessment

The scores earned on the assignments ranged from 85% to 94%, which suggests that the students were successful in reaching the learning goals. Assessing the direct contribution of the simulation to student learning, however, is difficult as it is only one week in a semester. All students participated in the simulation and, thus, there was no control group to compare performance against. Furthermore, we cannot make a direct comparison between the grades given to students in the term the simulation was used and previous terms because the assignments following the simulation were much more difficult. In previous terms, the students were given a clear set of requirements and only needed to create the models. The instructors did not observe any noticeable differences in the technical quality of student models, though the expert judgment of the faculty was that the simulation did lead to greater learning as assignments became more complex and a wider range of skills were necessary to complete those more rigorous assignments. For example, the students were more restricted in the assumptions they could make because more facts were presented in the simulations package. In future semesters, additional metrics will be collected so that the direct impact of the simulation on learning can be quantified.

5. CONCLUSIONS

The simulation emerged out of our shared desire to create a problematic business context that the students, as a whole, could understand while experiencing some degree of vagueness and uncertainty. The simulation was prerequisite to creating an opportunity for students to more fully develop their requirements determination and modeling skills.

Providing a chance for the students to become part of the system they were modeling, presents an additional, complementary approach to understanding requirements determination techniques. A simulation like Fetch encourages a greater degree of student involvement in the assignment leading to more active involvement.

To the best of our knowledge, we know of no other program that has developed an IS simulation where (1) the students have a hands-on experience running a fictional business in order to "live" the requirements, (2) the experience is shared by two courses demonstrating the big picture of how the techniques learned in each class capture different, complementary aspects of systems definition, and (3) the experience is a focal point throughout the semester.

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Appendix A. Description of Preparation for Simulation

1) Form teams and assign roles to students.
   a) General Manager
   b) Operations Manager
   c) OE Clerk
   d) PO Clerk
   e) Shop Floor Employee
   f) Shipping Clerk
   g) Quality Control Specialist
2) Prepare Rooms
   a) Move desks and chairs into plant configuration (see Figure 2)
   b) Post signs indicating department
   c) Setup bins and the appropriate number of raw goods and finished goods
3) Distribute job descriptions and procedures to each department
   a) Exhibit A – Customer Order
   b) Exhibit B – Finished Goods Inventory on Hand
   c) Exhibit C – Shipment Log
   d) Exhibit D – Work Order
   e) Exhibit E – Finished Goods Shortage Memo
   f) Exhibit F – WO Quality Guidelines
   g) Exhibit H – Reorder Point Memo
   h) Exhibit I – Purchase Order Form
   i) Exhibit J – Raw Goods Inventory on Hand
   j) Exhibit K – Suppliers
   k) Exhibit L – Receipt Log
   l) Exhibit M – Contractual Price List
   m) Exhibit N – Product Price List
   n) Exhibit O – Customer Profile
   o) Exhibit P – Raw Goods Consumption Report
   p) Exhibit Q – Inventory Allocation Notice
   q) Exhibit R – Customer List
   r) Exhibit S – Finished Goods Replenishment Notice
   s) Bill of Materials
4) Run 30 minute exercise
5) Collect number of customer orders shipped
6) Breakdown Room

Appendix B. Purchase Order Clerk Procedures

1. Retrieve updated Raw Goods Inventory on Hand from mailbox.
2. Use Raw Goods Inventory on Hand and Reorder Point Memo to determine which items must be ordered.
3. Create a Purchase Order for the appropriate supplier to order the needed raw goods. The supplier address is on the Suppliers list, and the prices are on the Contractual Price List. Repeat until all needed raw goods are ordered. Make two copies of each Purchase Order. Record the Purchase Order in the Purchase Order Ledger for each one created.
4. Put one copy of the Purchase Order in the Outgoing Mailbox, and send one to the Shipping Dept.
5. When Purchase Orders are returned from the Shipping Department and marked received, update the Purchase Order Ledger.

Appendix C. Survey Results

Item	Area of Interest	Frequency							Mean	St. Dev.
		1	2	3	4	5	6	7		
As a learning experience, this simulation was more productive than listening to a lecture.	Productive	1	1	2	7	19	35	25	5.74	1.19
As a learning experience, this simulation was more enjoyable than listening to a lecture.	Enjoyment	1	0	0	3	8	27	51	6.36	0.98
Compared to group projects in other business-related courses, this simulation was more productive.	Productive / Teams	1	0	2	6	19	38	24	5.80	1.09
Compared to group projects in other business-related courses, this simulation was less enjoyable.	Enjoyment / Teams	30	39	12	5	2	1	1	2.08	1.16
As a result of completing this simulation, I have a greater appreciation for what it takes to work in a group.	Teams	2	3	1	8	18	44	14	5.50	1.29
This simulation should not be used in future classes.	General	43	32	6	7	1	0	1	1.83	1.10
This simulation was one of the best parts of the systems analysis and database courses so far.	General	1	0	2	11	13	36	27	5.79	1.18
1= Strongly Disagree, 2=Disagree, 3=Somewhat Disagree, 4=Neither Agree nor Disagree, 5=Somewhat Agree, 6=Agree, 7=Strongly Agree										

Areas of interest:

Productive — They were asked about the relative learning productivity of the simulation and should it be used again.

Enjoyment — They were asked which was more enjoyable – the simulation or traditional lectures.

Teams — They were asked if they better understood the effort required to effectively work in teams.

Steganography and Cryptography Inspired Enhancement of Introductory Programming Courses

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Abstract

Steganography is the art and science of concealing communication. The goal of steganography is to hide the very existence of information exchange by embedding messages into unsuspicious digital media covers. Cryptography, or secret writing, is the study of the methods of encryption, decryption and their use in communications protocols. Steganography manipulates data to ensure the security of information, but the concept of steganography differs from cryptography. Cryptography obscures the meaning of a message, but it does not conceal the fact that there *is* a message. The goal of cryptography is to make data unreadable by a third party, whereas the goal of steganography is to hide the data from a third party. We present a way to integrate steganography and cryptology examples into introductory programming courses. This enrichment promotes active involvement in the course and provides opportunity to engage students in experimental problem solving and collaborative learning to enhance critical thinking.

Keywords: Steganography, cryptology, problem solving, active learning, engagement, introductory programming.

1. INTRODUCTION

Steganography is the art and science of concealing communication (Kessler, 2004; Provos & Honeyman, 2003). The goal of steganography is to hide the very existence of information exchange by embedding messages into unsuspicious digital media covers. Cryptography, or secret writing, is the study of the methods of encryption, decryption, and their use in communications protocols. Both techniques manipulate data to ensure the security of information, but the concept of steganography differs from cryptography. Cryptography obscures the meaning of a message, but it does not conceal the fact that there *is* a message. The goal of cryptography is to make data unreadable by a third party, whereas the goal of steganography is to hide the data from a third party. Both techniques have an ancient origin, but the modern field is relatively young. Cryptography and steganography are fundamental components of computer security. Cryptography provides mathematical foundations of computer security and it is a well-developed and highly researched field of computer science. In contrast, the interest in steganography has increased only in recent years, when it was recognized that the use of steganographic technique might become a security threat. Furthermore, the first verified use of steganography for espionage purposes was recently confirmed by FBI in the case of Russian spies (Stier, 2010), who used steganography techniques to hide sensitive information in images on the internet. This accusation by the FBI has made steganography a topic of public interest, and has caused concern regarding the number of images on the internet which could potentially hide secret messages (*Zielinska*, *Mazurczyk* & *Szczypiorski, 2014)*. Due to the crucial importance of cryptography and steganography in computer science, it seems that at least some examples should be integrated into the introductory programming courses - first core courses in the undergraduate computer science (CS) and computer information systems (CIS) curriculum. Furthermore, these concepts provide an opportunity to enhance analytical and critical thinking including creativity and ethical analysis which are fundamental characteristics of the information systems (IS) profession as stated in the latest IS 2010 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems (Topi, et al., 2010). The current paper discusses our experience integrating steganography and cryptography examples into freshman year programming courses taught on Python and C.

2. GOALS AND OBJECTIVES

Computer security is long recognized as an excellent source of the interesting projects that could be integrated into introductory programming courses. The merit of steganography-oriented assignments was discussed previously by several authors (Courtney, M. & Stix, A., 2006; Hunt, 2005; Stevenson, D., Wick, M., & Ratering, S., 2005; Markham, 2009; Ryder, 2004). Various approaches to teach cryptography courses for undergraduates were documented in several papers (Aly & Akhtart, 2004; Gandhi, Jones, & Mahoney, 2012; Hsin, 2005; Huraj, L. & Siladi, V., 2009). In addition, one of the authors of the current paper had a successful experience integrating these topics into a computer forensics course for non-majors (Kortsarts & Harver, 2007), and both authors had a successful experience integrating a public-key cryptography component into a programming course (Kortsarts & Kempner, 2010). In contrast, the focus of the current work is on the integration of cryptography and steganography concepts into freshman year introductory programming courses that are taught on Python and C without use of any image processing and graphics libraries. We present an idea of designing the course centered around these topics and emphasizing the merit of cryptography and steganography inspired programming assignments to develop and enhance programming and critical thinking skills. The related assignments are integrated into the courses not as a separate module but through the entire curriculum, starting at the very first week of classes from the non-programming computer ethics component. In this paper, we focus on the programming part of the courses and emphasize algorithmic implementations. We design secure communication teamwork to help to promote collaborative learning. Our goal is to link main programming concepts to specific steganography and cryptography technique to promote achievement of the programming proficiency. The proposed enrichment helps to achieve the following goals: (1) engaging students in real world problem solving activities; (2) increasing students' motivation and interest in programming; (3) enhancing students' programming skills. Here we are discussing some known problems drawn from the advanced cryptology and computer security textbooks, as well as less known cryptography techniques, which are not covered in major texts. We are making these problems accessible to novice programmers. Proposed experiments create an enjoyable programming experience, spark students' interest, and increase their engagement in the course. Students show a great interest in discovering and decrypting hidden messages. They become highly motivated in algorithmic implementation of various steganography and cryptography techniques. Some of the coding schemes are revisited several times during the course, and students have an opportunity to observe their growing abilities to tackle more complex problems and design more elegant implementations as course is progressing. Furthermore, the proposed enhancement provides an opportunity to build a solid background for upper level technical electives such as cryptology, computer security and computer forensics.

3. COURSE CURRICULUM SUMMARY

One of our institutions offers an undergraduate program leading to Bachelor of Science degrees in both Computer Information Systems (CIS) and Computer Science (CS). Both majors take the two-course series Introduction to Computer Science 1 (CS 1), taught in Python, and Introduction to Computer Science 2 (CS 2), taught in Python and C, in their first year. The structure of each course is three hours lecture and three hours lab, four credits. The second institution requires students to take two introductory programming courses taught on C during their freshman year. While we do have slightly different course structures, the course curriculum is very similar and allows joint implementation of the proposed enhancement.

As previously mentioned, the first week of classes is devoted to the computer ethics component, which provides an excellent opportunity to start discussing computer security topic. This component is not a subject of this paper, and was previously reported in (Kortsarts & Fischbach, 2013).

Following computer ethics, we introduce students to the binary number system. We discuss binary, octal, and hexadecimal representations, as well as ASCII code.

The rest of the curriculum is standard for the introductory programming course. Over two courses we cover material including two-dimensional lists and dictionaries in Python, and up to two-dimensional arrays in C. One of our institutions has a more extended curriculum and covers simple data structures, including linked lists and trees in C.

4. STEGANOGRAPHY ENRICHMENT

The concept of steganography is first introduced through non-programming assignments as an effective way to illustrate binary system representation and add relevance to this topic in students' eyes. We discuss the simplest steganography embedding technique – least significant bit (LSB) insertion. To avoid confusion, we provide only limited information regarding various image representations, focusing only on a definition of 24-bits RGB (true color) BMP image format, which is a sequence of binary bits, three bytes per pixel in BLUE, GREEN, RED order. Each byte gives the saturation for that color component. In our approach, which from our experience worked the best for our students, the container file is a string of binary bits and the message to hide is a string of characters. Students use ASCII code to convert a string of characters to binary string, and then replace the last bit of each byte in the container to hide the information. The reverse procedure is applied to uncover the message.

For the non-programming assignment, we ask students to hide very short messages, starting from one letter, as shown in Figure 1, and increasing the message to three letter words.

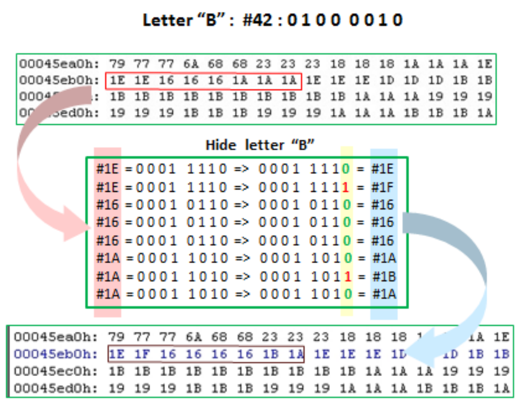

Figure 1: Hiding Letter B

To provide a visual support, we do utilize UltraEdit 32 to show students the binary representation of the bitmap images before and after the hidden message was inserted. We show students various ways to hide the message, starting from implementations that alter the original image. First, the text message is inserted as one block; then we separate the message into letters and insert each letter as a block replacing first byte of original image on each line. Neither of these techniques provides the proper hiding of information, and students can see strange behavior of the original image. We complete our discussion demonstrating the results of LSB embedding which works properly without image distortion, but we do discuss the limitations of this technique as well, when used in real world situations.

We revisit steganography LSB technique again after introducing one-dimensional lists, and this time students write computational implementation of this algorithm. One three-hour laboratory assignment is devoted to write a program, which hides information and recovers the hidden information, again, omitting all details of image representation. Students use UNIX redirection to input/output from/into file, but some years we do introduce file input/output in Python. To combine steganography and cryptography concepts under one umbrella, one of the last assignments is devoted to programming implementation of hiding encrypted message and decrypting recovered message. Students design a menu, which allows choosing from various cryptographic schemes to encrypt the message, which will be embedded into the image container.

5. CRYTOGRAPHY ENRICHMENT

We begin our cryptography journey discussing the process of secure communication scenario between two parties to introduce main cryptography terms. Secure communication between two entities starts with agreement on specific cryptography scheme or cipher, which is an algorithm for performing encryption and decryption. An encryption algorithm modifies the original message, plaintext, in a way that only designated receiver is able to read. The output of the encryption process is called encrypted message or ciphertext. When designated receiver would like to read a message, the ciphertext will be deciphered or decrypted using decryption algorithm. We also introduce students to the process of cryptanalysis, which is used to breach cryptographic security systems and gain access to the contents of encrypted messages without permission. There are additional concepts, such as encryption and decryption keys, which are more easily understood while introduced in the context of the specific cryptographic scheme.

Simple substitution ciphers

The first ciphers introduced to students belong to the group of simple substitution ciphers. The main idea behind these ciphers is to substitute one letter by another using a special substitution alphabet rule. We focus on two well-known ciphers belonging to this group: 1) Caesar cipher, in which alphabet is shifted forward three letters for encryption, and three letters backwards for decryption, for example the plaintext *dog* produces the ciphertext *GRJ*; 2) Shift cipher, a general form of Caesar, where the alphabet is shifted K letters forward/backwards, and K is a cipher key (Barr, 2001). For $K = 3$, we obtain the Caesar cipher. To encrypt, the plaintext letter P is modified using the following formula, $C = (P + K) \bmod 26$, and ciphertext letter C is computed. To decrypt, the similar procedure is applied and the desired plaintext letter is computed by the following formula, $P = (C - K) \bmod 26$. For instance, for key $K = 14$ and plaintext *dog*, the ciphertext is RCU. Assignments related to encryption and decryption of a single letter using Caesar and Shift ciphers implementations could be accomplished almost immediately, since they require only limited programming material. We revisit both ciphers after introduction of the loops. At this point students are capable to process a string of characters and output the results of encryption/decryption after each letter, which is still not a complete implementation. The full completion of the computational implementation of both simple substitution ciphers is done after introducing students to one-dimensional lists/arrays and explaining file input/output using programming language or input/output UNIX redirection operators. At this stage, in addition to implementing encryption/decryption algorithms, students are also introduced to the notion of cryptanalysis, specifically, brute force attack and proposed to write a computational implementation of this attack for shift cipher. The brute force approach in this case requires application of all possible shift keys, from 0 to 25, on the ciphertext to find an actual encryption key and the desired plaintext. We ask students to design a simplified interactive implementation, without utilization of the built-in dictionaries. The program finds and displays the decrypted message for each possible key. Students implement sentinel-controlled repetition based on the validity of the displayed message. The program terminates when the valid English sentence is revealed on the screen, which is a desired plaintext. To complete the process, the program also outputs the actual shift key.

Our goal is to apply these assignments to develop and practice programming skills. We explain this material on specific examples, omitting theoretical details and providing final formulas as known fact without mathematical proofs. Implementation of simple substitution ciphers provides an excellent opportunity to practice decision and loop programming structures, and simple processing of the one-dimensional lists/arrays. Since all calculations are performed on numeric values assigned to characters using the rule a/A $\leftarrow$ 0, b/B $\leftarrow$ 1,…, z/Z $\leftarrow$ 25, these examples require working with various data types - characters and integers - switching among them while moving from input to calculations and then to output, which is a struggle for novice programmers. Python provides more flexibility than C, but still requires explicit conversion to avoid any logic errors. While these ciphers are well suited for starting, one should note that they only require modifying the content of the array/list values, leaving the structure of the array/list unchanged. The next example requires array/list manipulations of a higher complexity.

Dynamic substitution cipher – Chaocipher

Recently, we also integrated into the course curriculum, a less known and more complex cipher, chaocipher, (Byrne, 1918; Rubin, 2010), belonging to the group of dynamic substitution ciphers. In these ciphers, the substitution rule is changed after each character is encrypted. To decrypt, the reverse procedure is applied. The chaocipher was originally invented by John F. Byrne in 1918, who claimed that the cipher is unbreakable. Unfortunately, the cipher didn't receive any recognition from US officials. Frustrated by the lack of interest, Byrne published four plaintext-ciphertext challenges in his autobiography, *Silent Years* in 1953 (Byrne, 1953). The cipher details were kept secret for many years. Things changed in 2010 when the National Cryptologic Museum library received archives from the members of the Byrne family with the explanation of the chaocipher algorithm, and there are direct links to many items of interest donated by Byrne family posted on the museum website (http://www.nsa.gov/about/cryptologic_heritage /museum/index.shtml). In our approach we closely follow the description of the algorithm published in July 2010 by Moshe Rubin (2010), providing further adaptation and clarifications for novice programmers. The chaocipher method uses two alphabets that are connected to each other. The encryption/decryption algorithm essentially consists of three parts, encryption/decryption of the letter, permutation of the left alphabet using specific rules, and permutation of the right alphabet using specific rules. These steps are performed continuously until the input (plaintext or ciphertext) is exhausted. This cipher requires swapping array/list elements, shifting blocks of the elements several positions left and right, and shifting all elements cyclically until certain conditions are satisfied. These operations are more complex compared to the processing done for the simple substitution ciphers, and require a higher level of algorithmic thinking. To ease the transition and increase the difficulty level gradually, we first permit students to use additional array/list storage, increasing the space complexity of the algorithm. As a complete implementation, students are required to implement all these array/list manipulations with minimal additional space usage. To avoid any attempts at plagiarism, we provide only cipher description and all necessary details to design a computational implementation. We emphasize the mystery around this cipher to keep students motivated and excited. We reveal the name and history of the cipher only after students complete writing the program, but before the collaborative testing step of the assignment. The mystery around this cipher and the interesting history attract students' attention. This cipher provides an opportunity to practice complex manipulations of one-dimensional arrays and lists data structures, utilizing a wide range of built-in Python lists methods and functions, and writing custom functions in C. From the best of our knowledge, this cipher is not covered in any cryptography textbooks.

Block ciphers, Hill cipher

While there are plenty of ciphers with witch to practice one-dimensional lists/arrays data structures, the options are limited when it comes to two-dimensional lists/arrays. The assignment based on Hill cipher provides an efficient way to integrate programming and cryptography topics. This cipher belongs to the group of block ciphers, in which the encryption and decryption process is applied to a block of characters rather than to single character. Hill cipher was invented by Lester S. Hill in 1929 (Hill, 1929; Barr, 2001). The key for this cipher is a square matrix of integers of size n, satisfying several special conditions: 1) all elements of the matrix are numbers between 0 and 25, since the size of the English alphabet is 26; 2) the determinant of the key matrix must be relatively prime to 26. For the encryption process, the plaintext is divided into a block of n letters and for each block of n letters; multiplication of the key matrix by vector is applied to obtain the block of n ciphertext letters. The process is repeated for all blocks. To decrypt, the same multiplication procedure is applied to the block of n ciphertext letters, but instead, substituting the original key matrix with its modular inverse.

We start this programming assignment with the matrix key of size 2, processing the blocks of size 2, gradually increasing the size of the matrix and the correspondent size of the blocks. For instance, we would like to encrypt the following word, ***code***, using Hill cipher and the matrix key

$$A = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} = \begin{pmatrix} 2 & 3 \\ 5 & 6 \end{pmatrix}$$

To encrypt, the plaintext ***code*** is divided into two blocks.

$$\begin{pmatrix} c \\ o \end{pmatrix} \begin{pmatrix} d \\ e \end{pmatrix}$$

After replacing the characters by their numeric values using the rule mentioned earlier, c ← 2, o ← 14, d ← 3, e ← 4 , each block is encrypted in the following manner:

$$A\begin{pmatrix}2\\14\end{pmatrix}=\begin{pmatrix}2&3\\5&6\end{pmatrix}\begin{pmatrix}2\\14\end{pmatrix}(\mathrm{mod}\,26)=\begin{pmatrix}20\\16\end{pmatrix}=\begin{pmatrix}U\\Q\end{pmatrix}$$

$$A\begin{pmatrix}3\\4\end{pmatrix}=\begin{pmatrix}2&3\\5&6\end{pmatrix}\begin{pmatrix}3\\4\end{pmatrix}(\mathrm{mod}\,26)=\begin{pmatrix}18\\13\end{pmatrix}=\begin{pmatrix}S\\N\end{pmatrix}$$

The resulting ciphertext is UQSN. To decrypt, the similar process is applied on the ciphertext, substituting key matrix A with its modular inverse. The general formula for inverse matrix 2x2 reads as follows:

$$A^{-1}=(\det(A))^{-1}\begin{pmatrix}a_{22}&-a_{12}\\-a_{21}&a_{11}\end{pmatrix}(\mathrm{mod}\,26)$$

In our case, we perform the following calculations, to obtain the modular inverse of the key matrix:

$$A^{-1}=(\det(A))^{-1}\begin{pmatrix}6&-3\\-5&2\end{pmatrix}(\mathrm{mod}\,26)$$

$$A^{-1}=(23)^{-1}\begin{pmatrix}6&-3\\-5&2\end{pmatrix}(\mathrm{mod}\,26)$$

$$A^{-1}=17\begin{pmatrix}6&-3\\-5&2\end{pmatrix}(\mathrm{mod}\,26)$$

$$A^{-1}=\begin{pmatrix}24&1\\19&8\end{pmatrix}$$

$$AA^{-1}=I=\begin{pmatrix}1&0\\0&1\end{pmatrix}(\mathrm{mod}\,26)$$

To decrypt and find a desired plaintext, the ciphertext is divided into blocks of two letters and each block is multiplied by the modular inverse of matrix key A.

$$\begin{pmatrix}24&1\\19&8\end{pmatrix}\begin{pmatrix}20\\16\end{pmatrix}(\mathrm{mod}\,26)=\begin{pmatrix}2\\14\end{pmatrix}=\begin{pmatrix}c\\o\end{pmatrix}$$

$$\begin{pmatrix}24&1\\19&8\end{pmatrix}\begin{pmatrix}18\\13\end{pmatrix}(\mathrm{mod}\,26)=\begin{pmatrix}3\\4\end{pmatrix}=\begin{pmatrix}d\\e\end{pmatrix}$$

Note, that all calculations are performed modulo 26. As in previous examples, we provide students with all of the necessary mathematical background. For this assignment, there is a substantial increase in complexity of mathematics, and consequently the level of the programming required, while progressing from smallest matrix size to the higher sizes. The maximal size of the matrix key and the block of letters in our lab assignment is four.

Two dimensional lists/arrays is not an easy topic to comprehend. To ease computational implementation, students are provided with a detailed top-down design, and structured guidance for each function. To implement the Hill cipher encryption and decryption algorithms, students compute the matrix determinant, check validity of the matrix key to ensure that the matrix is invertible modulo 26, and then compute the key matrix modular inverse, which differs slightly from a regular matrix inverse, with multiplicative inverse of determinant modulo 26 substituting for a regular inverse of the determinant. In addition, students implement the matrix by vector multiplication. After all preparation steps are complete, students are ready to process the plaintext/ciphertext in blocks of 2, 3, or 4 letters, based on the size of the key matrix, to produce a final result.

Hill cipher provides an excellent opportunity for students to become proficient in basic processing of two-dimensional lists/arrays data structures.

6. TEAM COLLABORATION

We incorporate two team work routines. For some assignments, students work in teams for the entire laboratory session. We pair weaker students with stronger students to promote active learning. Students work together on programming implementation as well as testing and submit a joint lab report. While this approach has certain advantages, such as exchange of knowledge and the possibility to improve for weaker students and to further improve through teaching for stronger students, we found that in order to be able to perform on the required level, students must work independently during most laboratory sessions. Since the level of prior programming experience varies substantially from student to student, in recent years we avoid team work during the programming step of the assignment to make sure students are not taking advantages of their peers. We mostly apply the second collaborative learning approach in which students work in teams only to test their programs and to write a lab report. The testing process begins with secure communication session. Students exchange encrypted messages between team members and then decrypt messages using their own program. Successful decryption indicates a first step toward fully accomplished assignment. We found that the collaborative work during the testing and revision step of the assignment enhances students' understanding and creates an engaging environment. We ask students to submit their program twice, before, as well as after the testing and revision step. This allows proper grading and ability to track students' error corrections in order to gather information about the most common mistakes and address these issues before the next assignment.

7. SUMMARY

This paper presents our experience teaching an introductory programming course sequence using a computer security theme. Students practiced the main programming concepts on assignments inspired by steganography and cryptography. To assess the students' experience, we applied an indirect assessment tool and designed a short post-survey that included several open-ended questions eliciting and asked student feedback. Students commented on the level of their engagement, interest, curiosity, and active learning opportunities during the laboratory assignments related to computer security topics. We also asked students to comment on the effectiveness of these assignments to enhance programming skills compared to the various assignments related to other topics we to during the course. Overall, students provided positive feedback, especially emphasizing the impact of the team collaboration during the testing step. Students commented that the requirement to find logical errors in their peers' programs significantly promoted comprehension of the main programming concepts. They also commented on their excitement of finding proper testing inputs to discover tricky logical bugs. Based on the students' post-survey results, informal discussions, and comments from teaching evaluations, we could state that the proposed enhancement of the introductory programming courses was a successful addition to our previous positive experience with enrichment of the freshman programming course (Kortsarts & Kempner 2012). Current enrichment expands the pool of interesting and engaging assignments for this course, and we are planning to continue to work in this direction in the future. Some of the ciphers described above allow variations and modifications, and taking in account the mathematical background of the students, additional examples, such as Affine cipher and polyalphabetic substitution Vigenere (Barr, 2001) cipher could be a great addition to the already proposed set of ciphers. In addition, we propose to combine several ciphers and encrypt messages in a two-step process and then to apply a simplified cryptanalysis approach to decipher the message. We believe in changing course laboratory assignments often, and computer security based assignments provide further opportunities for successful course implementations.

8. FURTHER OPPORTUNITIES

We built our current project upon successful implementations of the single components over several years. Merkle-Hellman knapsack cryptosystem (Merkle & Hellman, 1978) was the first algorithm we introduced in the introductory programming courses sequence. We introduced additive knapsack, expanded to multiplicative knapsack, and finally discussed various cryptanalysis techniques. Programming assignments focused on encryption and decryption computational implementations, and on a dynamic programming algorithm to accomplish cryptanalysis attack. The detailed description of this project component was published in 2010 (Kortsarts & Kempner, 2010). In recent years we found that it is more efficient to cover this material in sophomore algorithms course, and focus on symmetric key cryptography schemes described above in the freshman introductory programming courses. In sophomore algorithms course students are better prepared to comprehend conceptually more difficult group of ciphers such as public key or asymmetric ciphers. Some examples of the ciphers that work well are RSA (Rivest, Shamir, & Adleman, 1978) and flipping coins over the phone, which uses a similar protocol, introduced by Blum in 1983 (Blum, 1983; Trappe & Washington, 2006), and it is based on the Rabin cryptosystem (1979). While students are capable of completing computational implementation of these ciphers and games in the freshman programming courses, conceptually, these algorithms require a higher level of maturity and appropriate mathematical background for successful integration into the course curriculum. By the end of the sophomore year, most students complete a discrete mathematics two-course sequence, ensuring their abilities to comprehend these less intuitive cryptography schemes. While these ciphers provide fewer benefits to accomplish our goals in freshman programming courses compared to symmetric ciphers described above, they are an excellent enhancement for the sophomore courses.

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The Flipped Classroom in Systems Analysis & Design: Leveraging Technology to Increase Student Engagement

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Abstract

Problems associated with the ubiquitous presence of technology on college campuses are discussed and the concept of the flipped classroom is explained. Benefits of using the flipped classroom to offset issues associated with the presence of technology in the classroom are explored. Fink's Integrated Course Design is used to develop a flipped class approach to the author's Systems Analysis & Design course, and a resulting classroom module is provided as an example. Results of the initial use of this approach are discussed. It is concluded that the use of the flipped classroom in systems analysis and design definitely increases in-class student focus and engagement and as a result helped to increased student learning of both program specific and course specific student outcomes. Further longitudinal studies are suggested to determine effects of employing the flipped classroom approach on the continuing attainment of student learning outcomes.

Keywords: flipped classroom, systems analysis and design, integrated course design, student learning outcomes, formative assessment, summative assessment.

1. INTRODUCTION

The purpose of instruction and all other classroom learning activities is to promote student learning. All decisions relating to a given course, from the selection of reading materials to the design of in class activities to the assessment process itself, should be judged by their contribution to this end.

The speed at which technology is developing has flattened the world and played a major role in fostering changes in the educational process, and it is generally accepted that changes in educational technology have greatly influenced the way in which we learn and teach in higher education. But what is truly important is not the presence of technological tools, but how the tools are used. Technology merely opens the door to new possibilities, but the student learning outcomes are dependent upon decisions we make regarding how best to employ these technologies.

Computers are important in education because they force us to reconsider how people learn, how people are empowered, and the very nature of learning and useful information. We cannot avoid the presence of computers in our colleges and universities; rather, it's almost impossible to enter a twenty-first century college classroom without seeing the overwhelming presence of technology. Even when professors choose to prohibit the use of smartphones, tablets, and laptops in the classroom, students still find a way to maintain a virtually continuous connection to their devices. In fact, it is readily apparent that one of the ways this ubiquitous presence of technology disadvantages students is serving as a distraction from learning process itself.

2. PROBLEM STATEMENT

At Quinnipiac University all students are required to have their own laptops and the entire campus has wireless Internet connectivity. Advantages associated with these institutional policies include: (1) everyone has access to online resources such as texts, graphics and videos; (2) information available in most online environments is up-to-the-minute, whereas most information systems texts contain outdated information by the time that they are published; (3) laptops and course management systems can be strategically employed to promote independent learning; (4) course material can be stored and archived on student laptops for future use; (5) blogs, wikis, etc. can be used to interact and work with students; and (6) students learn to use the technology simultaneously with learning the content of the course/discipline. But simultaneous to the presence of advantages are disadvantages that need to be circumvented to create a positive learning environment, including: (1) technical problems can arise which disadvantage the student(s) experiencing the problems; (2) mixed technological ability levels of the students; (3) slow internet connectivity; (4) lack of sufficient technical skills by both students and faculty, although this problem is far less common than it used to be; and (5) classroom management issues can arise because the course instructor may have difficulty keeping students attention due to the presence of distractions caused by the students being online.

Quinnipiac University has made an intentional institutional commitment to be an exemplar of Tagg's (2003) Learning Paradigm College. As such, almost all university decisions are made with respect to how they positively or negatively impact student learning. For us the central question evolving around the use of technology is, "How can we leverage the use of technology both within and outside of the classroom to improve our students' learning?" For us the question is not whether or not our students will have tablets and/or laptops in the classroom. Rather, our approach is to design classroom experiences that will maximize the advantages and minimize the disadvantages associated with the use of technology by our students.

3. INTRODUCTION TO THE FLIPPED CLASSROOM

"Flipping the classroom" has been an education buzzword for the last few years, driven in part by high profile publications in the *New York Times* (Fitzpatrick, 2012), *The Chronicle of Higher Education* (Berrett, 2012), and *Science* (Mazur, 2009). Substantively, "flipping the classroom" means that students gain first exposure to new material outside of the classroom, usually by either reading provided or online material and/or viewing lecture videos, and they use class time to do the more difficult conceptual work of assimilating that knowledge through problem-solving, discussion, debates or other active learning strategies. In terms of Bloom's revised taxonomy (Anderson & Krathwohl, 2001), this means that students are doing the lower levels of cognitive work (gaining knowledge and comprehension) outside of class, and focusing on the higher forms of cognitive work (application, analysis, synthesis, and/or evaluation) in class, where they have the support of both their peers and the course instructor. This model contrasts from the traditional model in which "first exposure" occurs via lecture in class, with students assimilating knowledge through homework; thus the term "flipped classroom."

The flipped classroom approach has been used for years in some disciplines, most notably within the humanities and the sciences. Walvoord & Anderson (1998) promoted the use of this approach by proposing a model in which students gain what they called "first-exposure learning" prior to class and focus on the "processing" part of learning (synthesizing, analyzing, problem-solving, etc.) in class. To ensure that students do the preparation necessary for productive class time, they propose an assignment-based model in which students produce work (writing, problems, etc.) prior to class. The students then receive productive feedback through the processing activities that occur during class, reducing the need for the instructor to provide extensive written feedback on students' homework. They provide numerous examples of how this approach has been implemented in various disciplines such as history, physics, and biology classes, thus suggesting its broad applicability.
A similar approach was referred to as the "inverted classroom" in the field of economics (Lage, Platt, & Treglia, 2000). Additionally, Mazur & Crouch (2001) describe a modified form of the flipped classroom that they term "peer instruction." Like the approach described by

Walvoord & Anderson, and that of Lage, et al., the peer instruction (PI) model requires that students gain first exposure prior to class, and uses assignments (in this case, quizzes) to help ensure that students come to class prepared. Class time is structured around alternating mini-lectures and conceptual questions.

4. THEORETICAL BASIS OF THE FLIPPED CLASSROOM

How People Learn, the seminal work from Bransford, Brown & Cocking (2000), reports three key findings about the science of learning, two of which help explain the success of the flipped classroom. They assert that, "To develop competence in an area of inquiry, students must: a) have a deep foundation of factual knowledge, b) understand facts and ideas in the context of a conceptual framework, and c) organize knowledge in ways that facilitate retrieval and application." (p. 16)

By providing an opportunity for students to *use* their new factual knowledge while they have access to immediate feedback from peers and the instructor, the flipped classroom helps students learn to correct misconceptions and organize their new knowledge such that it is more accessible for future use. Furthermore, the immediate feedback that occurs in the flipped classroom also helps students recognize and think about their own growing understanding, thereby supporting their third major conclusion that, "A "metacognitive" approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them." (p. 18). Although students' thinking about their own learning is not an inherent part of the flipped classroom, the higher cognitive functions associated with class activities, accompanied by the ongoing peer/instructor interaction that typically accompanies them, can readily lead to the metacognition associated with deep learning.

5. KEY ELEMENTS OF THE FLIPPED CLASSROOM

The flipped classroom can be successful only if sufficient attention is paid to its key components. While different authors appear to espouse different key components, essential components common to all interpretations of the flipped classroom include the following:

Provide an opportunity for students to gain first exposure prior to class.

The mechanism used for first exposure can vary, from simple textbook or online readings to lecture videos to podcasts or screencasts. Videos can be created by the course instructor, or found online from sources such as YouTube, the Kahn Academy, MIT's OpenCourseWare, Coursera, or other similar sources. The pre-class exposure does not need to be high-tech; students can be asked to simply complete pre-class reading assignments and/or engage in writing-to-learn exercises.

Provide an incentive for students to prepare for class.

In all cases, students should be required to complete a task associated with their preparation, and that task should associated with some points or percentage toward their final course grade. The assignment itself can vary, ranging from online quizzes to worksheets to short writing-to-learn assignments. In each case the task should provide an incentive for students to come to class prepared by speaking the common language of undergraduates: points. In many cases grading for completion rather than effort may be sufficient, particularly if in-class activities will provide students with the kind of feedback that grading for accuracy usually provides.

Provide a mechanism to assess student understanding

The pre-class assignments that students complete as evidence of their preparation can also help both the instructor and the student assess understanding. Pre-class quizzes can also allow the instructor to practice Just-in-Time Teaching (Novak, G., Patterson, E., Gavrin, A. & Christian, W., 1999), which means that the instructor can tailor class activities to focus on the elements with which students are struggling. If automatically graded, the quizzes can also help students pinpoint areas where they need help. Pre-class worksheets also can help focus student attention on areas with which they are struggling, and can serve as a departure point for in-class activities, while pre-class writing assignments can help students clarify their thinking about a subject, thereby providing for richer in-class discussions. Most importantly, the use of pre-class activities provides for the time needed to supply students with much needed feedback in class, reducing the need for instructors to provide extensive commentary outside of class (Woolvard & Anderson, 1998). Additionally, many of the activities used during class time (e.g., clicker questions, debates, etc.) can serve as informal checks of student learning.

Provide in-class activities that focus on higher level cognitive activities
Given that the students have gained basic knowledge outside of class, class time can now be spent promoting deeper learning. The in-class activity selected will be dependent upon both the learning goals of the course and the culture of the discipline. For example, Lage, Platt & Treglia (2000) describe experiments students did in class to illustrate economic principles, while Mazur et al. (2001) focused on student discussion of conceptual "clicker" questions and quantitative problems which focused on physical science principles. Other in class activities may consist of debates, data analysis, or synthesis activities. What is important, regardless of the activity chosen, is that students are using class time to deepen their understanding and increase their skills at using their newly acquired knowledge.

6. DESIGN OF THE FLIPPED SYSTEMS ANALYSIS AND DESIGN CLASSROOM

The "flipped" version of the author's Systems Analysis & Design (SAD) course was designed using Fink's (2003, 2005) principles for integrated course design. Particular attention was placed on developing an active-learning environment for the course consistent with the recommendations of both Bonwell & Eison (1991) and Meyers & Jones (1993). In addition to these two seminal works, Richlin's (2006) *Blueprint for Learning* is one of many excellent sources for effective active learning strategies, and Michaelson, Knight & Fink (2002) provide a primer for the effective use of active learning in small (3-5 person) groups in both large and small classes.

Step 1: Course Situational Factors
The initial step in designing the course was to carefully size up the course situation factors. Situational factors provide the backdrop against which important course design decisions will be made. There are a number of potentially important factors that might affect the design of the course, including:
Specific Context of the Teaching/Learning Situation

- This is the first course beyond the introductory course and a prerequisite to all other courses in the major
- The course meets two mornings per week for 75 minute class periods
- Class size is between 25 and 30 students which implies 8-10 3-person teams per class

General Context of the Learning Situation

- Must cover 4 ABET program-level student learning outcomes
- Additionally the course has been assigned several course-specific student learning outcomes
- Need to develop and deploy performance indicators and rubrics for all course student learning outcomes
- Employ both formative assessment designed to increase student learning and individual student summative assessment as a basis for grading
- Employ a flipped classroom approach with active learning in class strategies

Characteristics of the Learners/Students

- CIS majors & CIS Minors (might be 1-2 additional students exploring the major or minor)
- Range from 1st semester sophomores to 1st semester seniors, but mostly sophomores and juniors
- Almost all students enrolled are full-time students, though many hold part-time jobs during the academic year which makes for difficult logistics to arrange for team meetings out of class

Physical Factors

- Classroom on top (2nd) floor of building; windows facing west (cool in morning, very warm by mid-afternoon)
- Wireless internet access present and very reliable
- Classroom seats 50 maximum; provides room for students to spread out in groups given the class size

Characteristics of the Teacher

- Taught course for many years and well-versed in traditional SAD techniques
- Well versed in the Scholarship of Teaching and Learning
- Teaching strengths are in interacting with students; weakness in leading class discussions

Step 2: Course Learning Outcomes
Student learning outcomes are assigned to the SAD course at both the program level and at the course level.
Program Level Learning Outcomes per ABET Accreditation

- (b) an ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- (f) an ability to communicate effectively with a wide range of audiences
- (g) an ability to analyze the local and global impact of computing on individuals, organizations, and society

- (j) an understanding of the processes that support the delivery and management of information systems within a specific application environment

Course Level Learning Outcomes – students will understand and be able to use

- Structured systems development methodologies
- Feasibility analysis, including Excel as a tool for cost/benefit analysis
- Data gathering techniques (interviewing, observation, documentation, and questionnaires)
- Process Model and Data Modeling

Step 3: Feedback and Assessment

In the typical content-centered course, multiple-choice questions from publisher-supplied course supplements are frequently used to construct exams to determine whether or not students have mastered the content. These exams are examples of summative assessment and are used to assign course grades. But in a learner-centered course, where the focus is on enhancing the quality of student learning, a more sophisticated assessment approach is needed. In such courses the goal of assessment is not to assign grades, but rather to determine if students are ready for the next activity after the current activity is completed. In particular, course assessments for the SAD course were designed to:

- *Be Forward-Looking*. One or two major course ideas were formulated by identifying situations in which students are likely to use what they have learned. Then students were required to replicate those situations with questions, problems, or issues.
- *Use Performance Indicators:* For the major learning goals, three to five criteria that would distinguish exceptional achievement from poor performance were identified. Then the instructor and students together wrote two or three levels of standards for each of the performance indicators. In effect, the course instructor involved students in creating rubrics that were used to evaluate their own performance based on their jointly defined performance indicators
- *Include Self-Assessment:* In-class activities provided ample opportunities for students to actively engage in both self-assessment of their own performance and assessment of their teammates' performance, relative to the performance indicators that students own because they helped to create.
- *Provide Feedback:* Procedures were developed that allowed the course instructor to provide feedback that was frequent, immediate, and discriminating (based on clear performance standards and expectations).

The Resulting SAD Course

The flipped classroom for the SAD course was first implemented in the fall of 2013, and is currently in its second iteration. The class consists of an opening unit which concludes with students being assigned to project teams, after which the teams are assigned to improve a particular system/ application either on campus or off campus.

The typical classroom unit consists of the following pattern:

- Students receive a research question at the close of the prior class;
- Students post their individual answers to the research question to the course management system no later than midnight of the evening prior to the class session in which the topic will be covered in class;
- The actual class session opens with a 10-15 minute comparison of the student answers and the class searches for commonalities in the answers, following which the students collectively decide which information to archive for summative assessment at a later date;
- Students then apply their understanding of the answers to their particular system or application.

For example, applying the pattern to the SAD class session covering System Requirements:

- Student Research Question: What are system requirements? What is the difference between functional system requirements and non-functional system requirements?
- In class, after the opening discussion, student project teams work together to define the functional and non-functional system requirements for their system or application.
- Project teams quickly come to realize that they cannot accurately define their requirements without input from the system stakeholders (a topic that was covered 2 weeks earlier in the course).
- Students are then provided with their research question and/or assignment

that is due prior to the next class session. In particular, students are asked to find commonly employed techniques to gather data and to determine which data gathering technique(s) would be most appropriate to collect data from each class of stakeholder, which provides input for the following class session which covers Data Gathering Techniques.

Student postings to the course management system are usually graded on a 2-point scale with 0 = answer not submitted by the deadline; 1 = standard Wikipedia answer; 2 = additional source(s) used to provide their answer. No late postings are accepted because all research assignments are posted to the course management system well in advance of the required due dates.

At the close of each class session, students and faculty together decide which information would be best archived for those students who missed class due to illness or other higher priority interventions. This archived material becomes the basis for summative assessments that provide for individual accountability in what is predominantly a team-based course producing team-based project deliverables.

It is important to note that the flipped classroom approach employed herein is not merely a synonym for either viewing online videos or searching for information on the internet. In fact, it is the in-class interactions and carefully designed meaningful learning activities that occur during the classroom face-to-face time that are the most important part of the flipped classroom. Students do not work without structure in class, nor do they work in isolation, nor do they spend the entire class time staring at a computer screen. Rather, the flipped classroom is an opportunity to increase intentionally designed and meaningful interactions between students and faculty.

7. RESULTS

The flipped classroom approach to teaching the SAD course was first deployed during the fall 2013 semester with surprisingly good results.

Student Learning Outcomes

Class time was now dedicated to a debriefing of the out-of-class content-based reading/research assignments followed by team-based applications of the content to a specific real system. The flipped classroom approach provided the course instructor with time to interact with individual student project teams as they applied newly learned concepts to their individual “live” applications. These team-based interactions supported student acquisition of specific ABET program level learning outcomes that were assigned to the course. Results on content-based examinations were similar to exam results from prior years, but results on application-based project team solutions to “live” applications have shown significant improvement.

In terms of specific program-level learning outcomes, given the increased interaction of the course instructor with individual project teams students were better able to (1) analyze a problem and define computing requirements appropriate to its solution, (2) communicate more effectively with a wide range of audiences, (3) exhibit a greater understanding of the impact of their solution on system/project stakeholders, and (4) better understand the processes under investigation than in prior academic years. The increased interaction of the course instructor with the project teams also fostered a deeper understanding and ability to execute the course specific learning outcomes.

Student Reaction to the Flipped Classroom

In general, student reaction to this method was very positive. While the occasional “we have to teach ourselves the material” comment did arise, it was usually quickly countered by other students in their project team. Most students preferred the autonomy of the project team learning on their own and supporting each other both inside and out of class as opposed to using texts that simply cost too much and are virtually outdated by the time that they are written. The flipped classroom in and of itself does not provide for outstanding student learning experiences; rather, it provides the time and space for instructors to design significant student learning experiences both in and out of the classroom and then carry them out. This becomes increasingly possible when the transfer of basic information is relocated to outside of the classroom. But then the responsibility falls upon the course instructor to use that time and space effectively. Indeed, students are not learning on their own; rather they are engaged in carefully designed learning activities both in and out of the classroom under supervision of the instructor and in cooperation with the members of their project team. By using carefully designed learning activities, the flipped classroom has definitely resulted in increased in-class student focus and engagement.

By far the greatest difficulty some students in the course had was not with the course content or even with the idea of flipped instruction; rather, the students' biggest difficulty has been with time and task management. The course is positioned as a first-semester sophomore course, and students are still quite early in developing both the methods and discipline to be engaged as self-directed learners. This "soft" skill is widely recognized as a desirable student learning outcome, but this outcome is seldom taught. In this course "we" routinely practice a "critical thinking" approach to business process improvement by identifying which piece of information the students next need to know to move forward with their project, search for that information using predominantly web-based resources, evaluate the relevance and validity of the information found, compare their results to the results of others, agree to results and conclusions which frequently requires the ability to compromise in team-based environments, and engage in all of these activities in an ongoing basis to complete their projects on time, within budget, and within constraints.

8. CONCLUSIONS/RECOMMENDATIONS

Employing Fink's Principles of Effective Course Design to design a flipped SAD course that employs active methods consistent with Weimer's learner-centered teaching and assessments, a course that also provides students with timely formative feedback, has resulted in a course that effectively deploys technology both in and out of the classroom. Students regularly complete their out-of-class preparatory activities because of the point value associated with the assignments. Students are more fully engaged in the classroom because they are actively working on projects which reinforce course core competencies. Further, students enjoy the course more than the traditional text-lecture-test because they are actively engaged in learning that they perceive to be meaningful.

The development and teaching of the course requires an ongoing attention to detail. The integrated course design focuses on developing course learning goals by first considering how the goals would need to be achieved within the context of situational factors, then defining feedback and assessment mechanisms consistent with performance indicators for each of the learning goals, and finally developing and applying teaching and learning activities both within and outside of the classroom to effectively leverage technology to actively engage students in the learning process. The newcomer to either the flipped classroom or the principles of integrated course design is well advised to proceed with caution, perhaps flipping a particular course unit as opposed to the entire course until well versed and comfortable with this technique.

Areas for further longitudinal study include the effect of deploying this flipped approach on student performance on summative assessments. While the use of the flipped classroom effectively blends the principles of direct instruction with constructivist learning theory, and while students are in fact more engaged in the classroom and are therefore assuming more responsibility for their own learning, the actual results of student learning and retention over time has yet to be assessed or evaluated and is a next logical step for further research investigation.

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Editor’s Note:

This paper was selected for inclusion in the journal as an ISECON 2014 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 2014.

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A Basic Set of Criteria for Evaluation of Teaching Case Studies: Students' Perspective

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Abstract

A study was performed to identify and evaluate characteristics, properties, and attributes of teaching cases that provide value to students. The items identified can be used to create an instrument to evaluate teaching cases during the review process for publication or by instructors to identify cases that would be most appropriate for courses.

Keywords: case, teaching case, case study, evaluation, student, structured group process

1. INTRODUCTION

The benefits of using teaching case studies include: applying conceptual, "textbook" knowledge to actual business scenarios, enhancing students critical thinking skills, learning how experienced practitioners analyzed problems and implemented solutions, reviewing the results of these decisions, improving the contextual complexity of decision-making in today's business environment (ethical, technological, cultural, and regulatory considerations), increased active learning, and the transfer of knowledge from others' experiences. Some of the drawbacks of teaching case studies are that they are historical in nature and may no longer be applicable or relevant and the decisions or problems may be so unique as to be non-generalizable to other functions, firms, or industries. The "case" for using teaching cases in IS education has been well-made by other scholars (Harris, 2002; Hackney, McMaster, & Harris, 2003) in editorials and a special issue of the *Journal of Information Systems Education* devoted to teaching cases.

The sources for teaching cases with information technology (IT) subject matter include the usual suspects (Harvard Publishing, Ivey, Darden, Stanford) as well as several outlets focused on IT including the *Communications of the Association for Information Systems, Journal of Information Systems Education, Information Systems Education Journal, Journal of Information Technology Case and Applications Research,* and *DATA BASE for Advances in Information Systems.* Each of these outlets has their own process for reviewing and publishing cases, some of these being more transparent than others. While it would be expected that the different outlets have different approaches based on their focus and objectives, it would also be expected that high quality teaching cases would share certain properties, characteristics, or attributes regardless of the outlet in which they are found.

Nearly all of the outlets mentioned above include a guide or guidelines for preparing and writing good cases (Cappel & Schwager, 2002; Farhoomand, 2004). Each of these guides suggests properties that a good teaching case should exhibit. For example, Cappel & Schwager (2002) suggest the following as "characteristics of a 'good' case" (specifically for an IT course):

- Addresses IS subject matter
- A clear sense of purpose
- Provides realism
- Is of appropriate length
- Is objective in presentation and tone
- Has a hook
- Addresses a timely topic
- Has been "pre-tested"

They also suggest that the first five of these characteristics are essential to an IT case.

In his reference guide for writing teaching cases Farhoomand (2004) suggests several design questions to consider (e.g. what theories are being taught), principles to follow (e.g. use simple and clear English), and characteristics of a good case (e.g. enough information for analysis, without providing the diagnosis).

The *Journal of Information Technology Case and Application Research* provides a review form that includes criteria for evaluating submissions. It includes criteria for the case such as the case being logical and well-written, appropriateness for an IT course, including enough data to address the discussion questions, and the case addressing issues not addressed by other cases. The form also includes several criterion focused on the teaching note such as whether it includes a logical plan, includes questions that will generate useful discussion, and provides logical alternative answers to questions. *JITCAR* also requires the submission of a research note to provide theoretical or conceptual information to be applied in analyzing and answering the case questions.

All of these guidelines and criteria are based on the viewpoint or perspective of the instructor or case writer and are based primarily on "best practices" developed anecdotally by instructors over the years. Little, if any, empirical evidence exists to validate whether these characteristics provide the best or most desirable learning experience to the student. To initially address the students' perspective of the relative value of the properties, characteristics, or attributes of teaching cases a field study was performed using a nominal group technique to identify and evaluate the criteria that students perceive to be most valuable to their learning.

2. APPROACH

A structured group process, the nominal group technique (NGT), was used to solicit the perceptions of a group of 27 MBA students in the final week of an IT strategy course that heavily used teaching cases throughout the term and was one of the last courses required in the program. The students in the course had substantial amounts of work experience prior to entering the MBA program, the average being greater than five years, with the minimum being three years. The NGT has been used in management (Van de Ven and Delbecq, 1974; Van de Ven and Delbecq, 1971), accounting (Havelka, Sutton, & Arnold, 1998), and in information systems (Havelka 2002, 2003) to collect qualitative data for exploratory and theory building research.

Structured group techniques have been used where fact gathering is a primary concern for group problem solving. When the desired objective of the research is the generation of a maximum number of ideas or alternatives, there is evidence that NGT is superior to personal interviews and surveys (Van de Ven and Delbecq, 1974; Van de Ven and Delbecq, 1971). Given the objective of this research, to identify a set of criteria to be used to evaluate teaching case studies, this approach has several advantages compared to other possible methods. First, by eliciting the constructs from participants without presenting *a priori* information, it is possible to identify new and different criterion compared to what has been suggested. Second, by using individuals that have experience with and interest in using the "object" under consideration, i.e. teaching cases, the most relevant criteria can be identified. Lastly, this approach allows the interaction among participants in a time efficient and cost effective manner to encourage synergistic creation of additional criteria.

The assumption that individuals who perform a task can provide valuable insight into the important factors influencing their ability to achieve a high level of productivity when performing the task is a key to the usefulness of the NGT. The basic notion is that fundamental concepts involved in a process can be identified by soliciting individuals that have experience and expertise in an area of interest. In the current study, students that have read, analyzed, and discussed teaching cases in several courses and are currently finishing a case-based course in IT strategy were asked to identify the characteristics, properties, or attributes that make a teaching case valuable. These students also were working full time and had substantial work experience prior to the course.

The technique used in this study is a variation of the approach developed by Delbecq, Van de Ven, & Gustafson (1982). The technique consists of five steps. All five steps were conducted during a single session that took approximately two hours. The technique is summarized below.

1. Introduction. An explanation of the purpose of the activities is given and the activities to be performed by the group during the session are presented. This is followed by a short presentation of the scope of the problem being considered (i.e. what criteria make a teaching case valuable?) and a description of the nominal group technique.

2. Generation of Factors. Each participant is asked to silently and individually generate a list of factors that they believe is an important characteristic, property, or attribute of a teaching case.

3. Listing of Factors. The factors generated in Step 2 are listed in a round-robin fashion on a flip chart (or white board or on a projection screen) for all participants to view and discuss for clarification. Discussion of the merits of an item are dissuaded at this point, the focus is on defining and understanding each item.

4. Evaluation of Factors. After all the potential factors are listed, the participants are asked to individually evaluate the factors by first separating them into two categories, critical or noncritical, and then ranking only those factors they deemed critical.

5. General Discussion. All participants are invited to continue the discussion in an informal location (or manner). This is useful to gather information about differences in views of the participants after they have performed their individual evaluations.

The output of the structured group process is a set of items that the group has identified as valuable characteristics, properties, or attributes of teaching cases. Additionally, the items have been evaluated as to their relative importance to the quality of teaching cases by the sorting and ranking procedures. This results in a set of criteria for judging the value of teaching cases from more to least important.

3. RESULTS

The results of the data gathering process are presented in Appendix I. All of the items identified during the session are presented in order based on the average ranking performed during the last step of the process. The ranks were calculated by averaging the ranks assigned by each participant and using a “placeholder” of 10 for the items that the participant did not consider to be critical (the greatest number of items considered to be critical by any one of the participants was 9).

Table 1 below gives an overview of the data collected. The table presents some information regarding the relative importance of the items identified by the number of participants that considered the item “critical.”

Total number of items identified	38
Number of items identified but not considered critical by any participant	5
Number of items considered critical by at least one participant	33
Number of items considered critical by at least five participants	13
Number of items considered critical by at least 10 of the participants	6
Number of items considered critical by more than half (15) of the participants	3
Number of items considered critical by at least 20 (the most) of the participants	1

TABLE 1: OVERVIEW OF RESULTS

Based strictly on an evaluation of the counts, it appears that there are very few items that the participants agreed on as being critical properties for a case study to be valuable. The exceptions to this are probably the top three items: Adequate information, multiple plausible alternatives, and a clear issue.

Logically, it seems that these three properties must be present for a teaching case to have value as a learning tool. If a case does not have enough information to allow the students to make a decision or evaluate alternatives its value would be limited to presenting or identifying the problem to be solved. This may be an appropriate learning objective in some situations, but this is probably in entry level or introductory course where shorter problems or scenarios would be more useful.

Similarly, if a teaching case is presented in a manner that would allow students with different perspectives, backgrounds, or prior knowledge to come to different conclusions or solutions to the same problem, this would increase the amount of knowledge sharing or critical thinking by forcing the students to logically defend their positions and by introducing them to a different perspective that they may not have considered.

The third property that should be required is the presentation of a clear conflict or issue to be resolved or debated. Without an issue or question to be addressed the students are not being asked to think themselves, they are being presented additional data to use in future problem-solving or decision-making. Again, this is appropriate in some situations where the case is being used to teach how a technique was applied or about an innovative solution, but this type of case is more like an exemplar.

3. ANALYSIS

To further analyze the data produced by the structured group process, the items identified were analyzed for similarities among one another to determine if their appeared to be any “groups” or “categories” of items. Based on this analysis seven different themes or categories of items emerged:

1. Case Selection & Course Fit
2. Problem Related
3. Problem Depth
4. Organization
5. Writing
6. Story
7. Information & Data

These themes are presented in Appendix II and defined and discussed in the following paragraphs.

Case Selection & Course Fit
Several of the items identified by the group are really not properties, characteristics, or attributes of a teaching case, rather these items are related to whether the case is appropriate for the course or how well it is prepared and presented by the instructor. These items are clearly important but are not relevant criteria for evaluating a teaching case.

One notable item that was included in this category that definitely is related to the evaluation of a teaching case is the use of teaching notes. This was the only item identified by the participants related to the teaching notes. This is not surprising given the participants’, i.e. students, perspective. They are only aware of the teaching notes for cases based on the pre-class discussion questions and the “execution” of the discussion of the case by the instructor.

Problem Related
A set of items identified appear to be characteristics of the problem being posed in the case itself and included whether the problem was understandable, how difficult (structured v. unstructured) it was, whether it had multiple solutions, and was unique or extended other more common problems. For instructors, the actual problem or problems presented in a case are most likely directly related to the learning objectives trying to be achieved.

Problem Depth
Another set of items that also seemed to be characteristics of the problem presented in the case, but that were in substance different than the previous set, focused on how narrow or broad the problem was. This primarily focused on whether there were multiple “aspects” of the problem such as financial/economic, social, cultural, governmental/regulation/legal, or ethical considerations. This theme also seemed to capture how “generalizable” the case problem was to different industries or functions.

Organization
The next set of items was related to the organization of the case. This includes the appropriate inclusion of exhibits, the proper use of “extraneous” details, flow of the story, and the logical sequence of sections in the case (nuance and building tension). This set of items captured the “overall” quality of the writing of the case. The next set of items captured the “technical” aspects of the case writing.

Writing
This set of items focused on the technical writing aspects of the case, such as grammar and spelling, the explanation of acronyms, the style, how easy or difficult to read, and the voice of the writer, i.e. was the case written from an unbiased point of view.

Story
Several of the items identified focused on the story being told; whether it was interesting, timely, and relevant. The currency did not seem

as important as whether the events depicted were still relevant, so a case focused on selecting an appropriate technology would not necessarily need to include the most cutting edge technologies. However, this theme does also include whether the case introduces new information such as new techniques, technologies, or tools.

Information & Data
The last theme that emerged focused on whether enough data or information was provided in the case to analyze or solve the questions given. Background data on the function, company, and industry being discussed should be included. This included whether the case included information regarding the business environment, and competitors, when relevant.

These seven themes emerged as higher level constructs that may be useful for improving the evaluation of cases published and used.

4. CONCLUSION, IMPLICATIONS, AND FURTHER WORK

Using data gathered from a structured group process conducted with a class of MBA students in an IT strategy course, a set of criteria (properties, characteristics, or attributes) useful for evaluating the value of teaching cases from a student perspective was identified.

Based on the group's evaluation of the criteria identified, it would appear that there is a wide, diverse perspective toward which criteria are most important for a valuable teaching case. Out of 27 student participants only three of the criteria identified were considered "critical" by more than half of the group.

There was not a single criterion identified that all the students agreed was critical. The item that received the most "votes" as being critical, *adequate information to make a decision*, was considered to be critical by (only) 20 of the 27 students.

This implies that the students had a wide difference of opinion about what makes a teaching case valuable to them. One implication of this observation is that it makes it more challenging for instructors to select cases that all or most of the students will find valuable.

Comparing the results of this research exercise to the characteristics of a good case suggested by others there are several similarities and some differences. One similarity is that the case must relevant to the course. For IT courses this means that the case needs to have some content that at least overlaps with the learning objectives of the course being taught.

Also consistent with the prior literature is the criteria that the case should have an explicit purpose, that it is clear what the case is trying to teach. Other similarities with suggested criteria include:

- Adequate information to make a decision or address the questions being asked.
- Provides a realistic and relevant set of facts.
- The case grabs the readers' attention, i.e. has a "hook" or catchy introduction.
- The problem being presented is new, different, or unique in some way.

Several differences were also found. From a "big-picture" perspective, one aspect that appears to be different for the students is the relative importance of some of the criteria. The students want the case to have a clear issue or issues and a problem with alternative solutions possible. On the surface, these may be self-serving wishes by the students. Instructors may want the students to identify the issues to be addressed as well as the solutions to be evaluated. Also, students may think that a problem that has many plausible correct solutions would be hard to get wrong (unfortunately, this is not the case in the classroom or the boardroom).

Several other differences were observed including:

- The case should provide "learning" that is transferrable across functions and industries.
- The problems should be complex enough to allow multiple viewpoints.
- The currency or "timeliness" was not as important as the relevance and generalizability of the problem.

These differences may indicate a need on the part of the instructor to consider the perspective of the student in the course, or it may simply be that the students' goals and objectives are not always in sync with the instructors and these differences are due to those discrepancies.

Another implication of the results is the importance of the selection, preparation, and presentation of the cases in the course. As noted earlier, the student participants included several criteria that were more teaching effectiveness criteria rather than teaching case quality criteria.

Based on the results of this study a Teaching Case Evaluation Criteria instrument was prepared for use by teaching case evaluators. This instrument is presented in Appendix III. The instrument was pilot tested by the same student participants of the IT strategy course. Each of the students participated in the writing of a teaching case during the course (a group project). They were then assigned one case each to review using the evaluation instrument. Based on the feedback from the students, the instrument captures most of the important criteria considered valuable by the students.

The results of the study can be used by IS educators and potentially educators in other disciplines as well, in three ways. First, the set of criteria can be used to evaluate teaching cases submitted to journals, or publishers, for publication. Second, the criteria could be used by instructors when selecting cases for use in the classroom. Instructors could weigh the criteria based on the specific learning objectives to be achieved or the type of course being taught. Lastly, the criteria can be used as additional guidance for case writers to improve the value of their cases to the student audience.

Additional development is needed to improve the evaluation instrument. Particularly, a study that captures the perspective of instructors that use teaching cases would be most valuable and would certainly result in additional criteria. Also, it would valuable to get additional input from students to determine if the criteria generated here are applicable to other situations.

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Appendix I

Rnk	Criteria	Cnt	Avg
1	Enough info to make decision	21	4.52
2	Multiple plausible options - able to debate	19	5.48
3	Clear conflict/issue to be solved	15	5.63
4	Story - interesting, characters, catchy intro, good location	12	7.00
5	Relevant issue that's transferrable across industries	11	7.33
6	Complex enough to be real	11	7.74
7	Identify critical items that are important (time, money, etc.)	8	8.15
8	Unbiased	7	8.44
9	Clear premise for learning opportunities (old but still teachable)	7	8.59
10	Background information to company, competitors, industry that is applicable to the decision	6	8.67
11	Financial impacts	5	8.70
12	Minimize extraneous details	5	8.89
13	Don't need to be in that industry to learn	5	8.96
14	Enough financial information to understand scope and boundaries	4	9.04
15	Teaching notes that help bring out insight and create conversation	4	9.15
16	Perfect grammar and spelling	4	9.19
17	Relevant to material in class	4	9.19
18	Recent / applicable to current business	3	9.37
19	Not long-winded - concise statement of problem	4	9.41
20	Inclusion of political/economic factors that are relevant	2	9.52
21	Includes new methods, tech, tools, etc.	2	9.52
22	Solution is multi-faceted	2	9.63
23	360 degree view (suppliers, buyers, etc.)	3	9.67
24	Org charts if there are numerous characters	1	9.70
25	Style / not dry	2	9.74
26	Memorable	1	9.78
27	Build tension	2	9.81
28	Unique issue or unique spin on common problem	1	9.85
29	Know internal, external competitive (be able to look it up)	1	9.85
30	Includes subtle nuances	1	9.85
31	Proper and good questions	1	9.85
32	Data for decisions	1	9.89
33	Body flows	1	9.93
34	Explain acronyms	0	10.00
35	Should include well-known firms	0	10.00
36	Several cases -> represents a variety of industries, styles	0	10.00
37	Client definition of technical jargon	0	10.00
38	Not too many exhibits / flip back and forth too much	0	10.00

Appendix II

Case Selection & Course Fit
Teaching notes that help bring out insight and create conversation
Proper and good questions
Relevant to material in class
Recent / applicable to current business
Several cases -> represents a variety of industries, styles
Problem Related
Multiple plausible options - able to debate
Clear conflict/issue to be solved
Complex enough to be real
Solution is multi-faceted
Unique issue or unique spin on common problem
Problem Depth
Financial impacts
Enough financial information to understand scope and boundaries
Inclusion of political/economic factors that are relevant
Relevant issue that's transferrable across industries
Don't need to be in that industry to learn
360 degree view (suppliers, buyers, etc.)
Organization
Org charts if there are numerous characters
Minimize extraneous details
Build tension
Includes subtle nuances
Body flows
Not too many exhibits / flip back and forth too much
Writing
Unbiased
Style / not dry
Perfect grammar and spelling
Not long-winded - concise statement of problem
Explain acronyms
Client definition of technical jargon
Story
Story - interesting, characters, catchy intro, good location
Clear premise for learning opportunities (old but still teachable)
Includes new methods, tech, tools, etc.
Should include well-known firms
Memorable
Information & Data
Know internal, external competitive (be able to look it up)
Enough info to make decision
Background information to company, competitors, industry that is applicable to the decision
Identify critical items that are important (time, money, etc.)
Data for decisions

Appendix III

TEACHING CASE STUDY EVALUATION CRITERIA

For each of the following items, indicate how well the case under review demonstrates that characteristic.

The case study includes enough information to make an educated decision about the issues involved.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

There are multiple plausible alternatives or options to allow reasonable debate and disagreement about the issues involved.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

There is a clear conflict, problem, or issues to be solved.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

The story is interesting, it has a catchy introduction, the characters are believable, the setting/location/context is good.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

The case contains issues that are relevant across multiple industries and functional areas.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

The case presented is complex enough to be realistic and demonstrate the intricacies and nuances of business decision making.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

The case identifies critical items, data, time, money that are important to the issues being presented.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

The case presents the relevant information in an unbiased fashion.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

The case presents a clear premise for learning opportunities, it is relevant to the current business environment/climate.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

The case contains the appropriate amount of background information applicable to the issues about the company involved, competitors, the industry, and business environment. (not too much or too little)

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1	2	3	4	5	6	7

What are the strengths of the case?

1.
2.
3.
4.
5.

What could be done to improve the case?

1.
2.
3.
4.
5.

Other comments or suggestions?

1.
2.
3.
4.
5.

Engaging Engineering and Information Systems Students in Advocacy for Individuals with Disabilities through a Disability Film Media Project

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Abstract

College curricula of engineering and information systems do not afford frequent engagement with individuals with disabilities. The authors of this research study analyzed the benefits of disability films for a community film festival of largely engineering and information systems students and individuals with developmental and intellectual disabilities. The authors learned that disability film media enables discernable engagement and advocacy of the students for the rights of individuals with disabilities. The authors also learned that the disability film media facilitates engagement and self-advocacy of the individuals for themselves. This study will be beneficial to instructors in engineering and information systems, and instructors in liberal arts, evaluating film media as an exciting method for involving students with individuals with disabilities on multidisciplinary projects of public service.

Keywords: community engagement, engineering and information systems curricula, disability film media, disabilities, multidisciplinary projects, public service.

1. BACKGROUND OF PAPER

"Disability is a natural part of life … it is the barriers that [others without disabilities] erect that are the problem … and it is time [the] media reflected this truth" (Levine, 2013).

Disability can be an alarming and even "frightening" consideration (Ross, 2013, p.1) for a college student without a disability. Disability covers different developmental and intellectual, physical, psychological, sensory and social impairments. Estimates denote a dimension of 49-54 million individuals with disabilities in this country (Riley II, 2005, p.15) – 19% of the population (United States Department of Commerce, 2008). Estimates denote a higher 650 million individuals with disabilities globally (International Labor Organization, 2013). The civil rights of individuals with disabilities in this country are covered in the Americans with Disabilities Act of 1990 (Riley II, 2005, p.7), but crime (Harrell, 2014) and discrimination if not disempowerment (Willis, 2012) is experienced frequently by them. 2012. The perception of others without disabilities of individuals with developmental and intellectual disabilities as persons of potential is flavored by fear, focus on impairments and prejudice (European Commission, 2013, p.21), inevitably precluding them as contributors in fruitful positions in industry. This perception may be dissipated by the impact of film industry media representation of them as a diverse population. The reality is that the influence of mainstream film media is of marginalization - misrepresentation and underrepresentation - of individuals with disabilities in society.

The misrepresentation of individuals with disabilities in mainstream film media is clear if they are defined by identifiable impairments distanced from individuals or students without disabilities (Disability Planet, 2013, p.3). Inherent in the misrepresentation of individuals with developmental and intellectual disabilities is that they are devoid frequently of intricate but normal personalities as people distinct from other people or students in a social setting (Disability Planet, 2013, p.2). The limiting media notion of individuals with disabilities is a factor in negative perception of them. The perception may even be of pity, victimization or vulnerability (Special Olympics, 2013). Their underrepresentation in mainstream film media is manifest in the often representation of them by individuals without disabilities (Norden, 1994), further perpetuating misrepresentations of reality (National Institute for Disability and Rehabilitation, 2002, p.41).

This misrepresentation in mainstream media is evident in a history of misleading portrayals. For example, in the original *The Phantom of the Opera*, the phantom is negatively portrayed through his disability as a freak, not as a human through his mobility as a person, effectively isolating him from society. In the recent *I Am Sam*, Sam is negatively portrayed through his disability as an oddity and a problem for society, but is concurrently portrayed positively through his parenting sensitivity (Nelson, 2001), a dual portrayal, although he is still isolated from mainstream society. Though individuals with intellectual disabilities in the films *Forrest Gump* and *Rain Man* are portrayed positively as sanitized savants, they are represented as powerfully special in society, inevitably isolating or marginalizing them from others not of resemblance or special (Barnes, 1992a). Individuals with disabilities in *Dumb and Dumber* and *There's Something About Mary* are portrayed in scenarios of snickering stereotyping (Carson, 1995) and in "r" (retarded) terminology in *Tropic Thunder* (Haller, 2010). The negative portrayals in the mainstream media are perpetuating stigmatization. The persistence of the stigmatization is precluding recognition of the rights of individuals with disabilities to be equal with individuals and students without disabilities. Those with disabilities have often responded with disability film media as a model of potential positivity for those with disabilities in society.

The proper representation of individuals with disabilities in disability films is considered to be evident in disability film festival maturation (National Institute for Disability and Rehabilitation Research, 2002, p.4). Film festivals are frequently perceived to be positively portraying them, not through their impairments but through their diversity and fortitude (Grandin and Panek, 2013) as persons. For example, festivals are perceived to be focusing on individuals with disabilities in a manner of positively portraying them in *Getting Up*, *The Importance of Tying Your Own Shoes* and *Wampler's Ascent* of the Reelabilities Disabilities Film Festival, and in *Deedah* and *Finding Fred* of the Sprout Film Festival, through their functioning as normal persons speaking for themselves (International Labor Organization, 2013, p. 27) in an ecosystem of society (Newman, 2013). The individuals with disabilities are the individuals with disabilities in the disability film festival media and in limited mainstream media, as for instance in *The King's Speech* and *The Station Agent*. The representation of them in the disability film festival media is not often perceived to be of the marginalizing and stereotyping stigmatization of the mainstream media (International Labor Organization, 2013, p.5).

The benefits of the disability film media are cited in the literature. The more individuals with disabilities are portrayed in proper representations in film media, the more pride they may have as members of society. The more individuals and students without disabilities learn of individuals with disabilities through the disability film media, the more respect they may have of this marginalized population. The literature indicates the influence of positive stories on individuals and students without disabilities (Saito and Ishiyama, 2005). Not evident however is the extent of the features of the disability film media perceived to impact the individuals and students with and without disabilities positively, or even negatively. Might not disability film festival media focusing on individuals with disabilities portraying themselves be perceived to be marginalizing or oppressing (Baird, Rosenbaum, and Toombs, 2009) if not stigmatizing them? Might not disability media producers inadvertently infuse sanitized sensitive situations that might be perceived by individuals and students with disabilities to be misrepresenting or negatively stigmatizing them? (Wall, 2013, p.1). In this paper, the authors analyzed, as part of a multidisciplinary project of largely engineering and information system systems students, the exact features and impacts of disability film media that influence perceptions of positivity.

2. INTRODUCTION TO PROJECT

"[Individuals with disabilities] need to be present … on screen … to [enable] a paradigm shift in perception for [them]; a real change in attitudes by all members of society can then [be] a reality …" (Council of Europe Disability Action Plan, 2006).

The authors of this study analyzed the features of disability film media in a community engagement project for a Disability Film Festival at Pace University. The project consisted largely of engineering and information systems students without disabilities of the Seidenberg School of Computer Science and Information Systems of Pace University, and of Polytechnic / New York University, a partnered school, which evaluated disability film media from dominant film festivals – Reelabilites Disabilities Film Festival, Sprout Film Festival and Welcome Change Productions. The project concurrently consisted of families, individuals with disabilities and staff from AHRC New York City, an organization for helping individuals with developmental and intellectual disabilities, partnered with the university, and evaluating the film festival media with the students. This project consisted further of limited mainstream film media that includes individuals with disabilities. The essence of the project was in evaluating the features of the disability film festival, and limited mainstream media, for proper representation of the individuals that impact if not influence perceptions of positivity. The evaluation of the features and impacts was conceptually formulated from engagement and advocacy factors in earlier projects of the first author (Lawler and Li, 2005, & Lawler and Joseph, 2013). The goal of the project was to furnish the highest media of proper representation of the individuals in the film stories for the Disability Film Festival at the university in spring 2014. The outcomes of the project were in increased knowledge of the capabilities and contributions of individuals with disabilities; and increased involvement in advocacy for proper representation of the individuals and in self-advocacy for disability rights – a modern and relevant inclusion of service-learning introduced into the curriculum of information systems.

The project consisted of 23 engineering and information systems students and 6 communications disorders liberal arts students, 29 students, for the fall 2013 – spring 2014 semesters. Each of the students learned of individuals with disabilities in a community engagement course of the first author (Lawler and Joseph, 2013) and the third author, in which they partnered in media productions of storytelling (Klanten, Ehmann, and Schulze, 2011), a few of which were previewed at the Sprout Film Festival. The students learned engagement and advocacy methods in proper representation of situations of individuals with disabilities, through the storytelling (Lawler and Joseph, 2013). Few of the engineering and information systems students learned of individuals with disabilities and disability issues in the curricula of the schools until they were in the community engagement course (Lawler and Joseph, 2013), with the individuals as mentor – mentee partners in the productions of the storytelling, and from the course the students were inherently motivated to be in the current project (Hoxmeier and Lenk, 2003). The project coincidently consisted of 22 families, higher-functioning individuals and staff from the non-profit organization, in the spring 2014 semester. There were 51 films or "flicks" from 3 – 21 minutes furnished by the film festivals and by extracted mainstream media, for condensing by 7 expert faculty and field professionals in disability studies at the schools to 9 films for evaluation by the families, individuals and staff and the students. The participants were definitely knowledgeable in disability issues, though the families, individuals with disabilities and the staff are more intimately knowledgeable in the issues than the students. Finally, the participants were led by the primary and secondary authors of this study, as to the features and the impacts that might or might not be the perceptions of positivity on the film media of the project.

Therefore, this study evaluated the features and the impacts of the disability film media, and the limited mainstream media, as to audience participant perceptions of positivity in the media, so that the film media of the project was presentable at the Disability Film Festival at Pace University in 2014. The manner in which the media represents individuals with disabilities is important in the response to the film stories: How might the features of the storytelling impact engagement of the audience participants on the project?; Is the project impacting importance and satisfaction from the storytelling?; How might the features of the storytelling impact advocacy of the participants on the project?; and Is the project at the university impacting self-sufficiency and sociality from the storytelling? If the media of the project properly represents individuals with disabilities in the storytelling, the impacts of the integrity of the media might influence perceptions of positivity (Wall, 2013, p.2). Few scholarly studies evaluate the disability film media systemically.

3. FOCUS OF PAPER

The authors evaluated the features and the impacts of the disability film festival media, by a focus on factors of engagement and advocacy of the audience participants of the project.

Engagement from Features of Media
Importance – Extent of impact from which the participants perceived the generic features of the disability media in proper representations of individuals with disabilities; and

Satisfaction – Extent of impact from which the participants perceived the specific features of the media productions in furnishing satisfaction from proper representations of the individuals with disabilities in the media.

Advocacy from Features of Media
Self-Efficacy – Extent of impact from which the participants perceived the storytelling of the disability film media in furnishing a foundation for them to be advocates for individuals with disabilities in society; and

Sociality – Extent of impact from which the participants perceived the storytelling of the media in influencing a motivation for them to be involved in other programs of public service with individuals with disabilities.

These factors were derived from earlier studies of the first author on movie productions of storytelling (Lawler and Joseph, 2013) and projects of public service with individuals with disabilities (Lawler and Li, 2005); and the features of the factors were determined from research sources (Riley II, 2005). The focus of the new study was on the benefits of disability film media as perceived by real individuals with disabilities and by students without disabilities, focusing on engineering and information systems students. The model furnished for the disability film media, and the mainstream media, increased proper representations of individuals with disabilities in the dual media and involved the students on a multidisciplinary project new to them.

4. METHODOLOGY OF PAPER

The audience of this research study consisted of engineering and information systems faculty and students of the Seidenberg School of Computer Science and Information Systems of Pace University, and of partnered Polytechnic / New York University, in New York City; and of families, individuals with disabilities and staff of partnered AHRC New York City. The methodology covered the fall 2013 – spring 2014 semesters. The films of the disability film media, and of the limited mainstream media, were evaluated by the participants and the authors in the following iterations:

- A checklist instrument, of 7 yes / no questions on characteristics of the participant students, 7 engagement Likert-like questions on generic features of importance of the media, 13 engagement Likert-like questions on specific features from satisfaction of the media, 7 advocacy Likert-like questions on the current impacts of self-efficacy from the media, and 9 advocacy Likert-like questions on the future potential impacts from sociality of the media, or 43 item questions, was evolved from interviews with the 7 expert faculty and field professionals in disability media studies and from research studies (Riley II, 2005);

- A choice of 51 films condensed to a manageable 9 films of 3 – 21 minutes, from mostly producers of the Reelabilities Disabilities Film Festival, Sprout Film Festival and Welcome Change Productions of individuals with different disabilities, was identified from interviews with the 7 expert faculty and professionals and by the second and first authors, for evaluation by the families, individuals and students;

- A design of 3 focus groups –22 families (8), individuals with disabilities (8) and staff (6) of the non-profit organization, 17 students without disabilities of Pace University and 12 students without disabilities at Polytechnic / New York City, or 51 focus group members – enabled evaluations independently of the features and the impacts of the 9 chosen films, moderated by the second and first authors;

- An evaluation of the 9 films by the 51 focus group members was performed anonymously on a Likert-like rating scale of 5 – very high in perceptions to 1 – very low in perceptions of the features and impacts of the films, with 0 – no perceptions, followed by a generic moderator participant review; and

- An interpretation of the resultant statistics was performed by the first and fourth authors of this study from the MAT LAB 7.10.0 Statistics Toolbox (Evans, 2014).

This methodology conformed generically to principles of critical and emancipatory participatory action research (Koshy, Koshy, and Waterman, 2011). The first, second and third authors educated the focus groups on the evaluation questions of the checklist instrument, before the members looked at the film media, and moderated the pre- and post- screenings of the sessions through principles of focus group research (Krueger and Casey, 2009). The fourth author of this study evaluated the instrument before the evaluations, in the context of construct, content and face validity, including content validity measured in the context of sampling validity.
(The checklist instrument is furnished in Table 7 of the Appendix.)

5. ANALYSIS OF DATA AND DISCUSSION OF FINDINGS

An analysis of the data from the focus group of engineering and information systems students without disabilities disclosed an appreciable engagement in importance (means = 3.47/5.00) and satisfaction (3.21), and in advocacy in self-efficacy (3.23) and sociality (3.14), or collectively 3.26, from the features of the disability film media. The evaluations of the films indicated a high of 3.98 (Film 1 - *Breadmakers*) and a low of 2.28 (Film 7 – *Miss You Can Do It* [Beauty Contestants]) collectively in engagement and advocacy of the group. Students without disabilities citing they were not in an earlier community engagement course, a course with individuals with disabilities or a community action program indicated an encouraging 3.26, 3.23 and 3.19 collectively in their engagement and advocacy. Those citing they were not exposed to individuals with disabilities in their families or in their own social settings indicated an also encouraging 3.32 and 3.29 collectively in their engagement and advocacy. The data from the students without disabilities indicated definite impacts from the film media.

Tables 1 and 2 detail the findings from the students without disabilities.

An analysis from the focus group of the families, individuals with disabilities and organizational staff disclosed a clear engagement in importance (3.79) and satisfaction (3.05), and in advocacy in self-efficacy (3.13) and sociality (3.60), or a collectively higher 3.39, from the film media. The evaluations of the films indicated a high of 4.23 (Film 3 – *The Interviewer*) and a low of 2.58 (Film 7 – *Miss You Can Do It*) collectively in engagement and advocacy of this group. The individuals indicated that they felt part of the actions portrayed in the film showings. They felt related to roles presented in situations of the stories and were highly sensitive to inadvertent characterizations (e.g., individuals with cerebral palsy - Film 7 – *Miss You Can Do It*). The data from the families, individuals with disabilities and staff also indicated definite impacts from the media as in the students without disabilities.

Tables 3 and 4 detail the findings from the families, individuals with disabilities and staff.
An overall analysis from the data of the focus groups disclosed discernable impacts in engagement in importance (3.64) and satisfaction (3.14), and in advocacy in self-efficacy (3.19) and sociality (3.35), or collectively 3.33, from the features of the media. The evaluations from this group indicated highs of 4.06 (Film 3 - *The Interviewer*) and 4.00 (Film 1 - *Breadmakers*) and lows of 2.42 (Film 7 - *Miss You Can Do It*) and 2.87 (Film 5 - *Life with Asperger's*) collectively in engagement and advocacy from the media. The participants indicated that except for Film 7 – *Miss You Can Do It*, perceived to be inappropriate condescending, almost all of the films depicted individuals with disabilities credibly and interacting in multidimensional normalized roles.

They indicated that the films focused on the individuals (e.g., Film 1 - *Breadmakers*), not on the disabilities of the people; and as applicable on inherent issues (e.g., bullying of individuals with autism and Down syndrome – Film 4 - *Bystander at Grocery Store*, prejudices of individuals with Down syndrome – Film 3 - *The Interviewer*, and poor special services on subways for individuals in wheelchairs – Film 6 - *The Commute*). They indicated that the films involved the individuals with others without disabilities in realistic roles and stories. The impacts were evident from the increased knowledge of the engineering and information systems students of disability issues learned in the films. Their future involvement in advocacy for individuals with disabilities indicated in the data was a refreshing insight. The impacts were evident further from indications of expanded future self-advocacy of the individuals with disabilities inspired by the media. The participants noted the generally high professionalism of the media, which were all documentary person-centered storytelling. In summary, the analysis of the findings noted perceptions of positivity from both the individuals and the students when film media portrays properly those with disabilities in our society.

(Spearman correlation coefficients of the factors across the films indicated statistical significance at the 0.01 level of significance across the films, with the lowest correlation of 0.4144 between satisfaction and sociality and the highest correlation of 0.8732 between satisfaction and self-efficacy; and Wilcoxon rank sum hypothesis testing of the factor participant ratings indicated statistical significance for sociality at the 0.05 level.)
Tables 5 and 6 document the findings from all the focus group participants of the study.

6. IMPLICATIONS OF STUDY

"It is not a competition … [individuals with disabilities] … do not have to earn or prove [their] place … [they] have a right just because [they] are alive" (Mason, 2002).

An impact of this research study is that the findings from the focus group data confirmed the benefits of disability film media in representing authentic and credible portraits of individuals with disabilities (Ross, 2013, p. 8) having multidimensional personalities (Barnes, 1992b). The film media in the study disclosed diverse experiences of the individuals living their lives like individuals and students without disabilities (International Labor Organization, 2013, p. 21). The implication is that proper realities and representations in the disability film media enable increased respect of individuals and students with disabilities.

Another impact is that the findings from the groups of engineering and information systems students without disabilities disclosed the benefits of engaging them on disability media projects. Even in colleges, few individuals or students without disabilities know others with disabilities. The more engineering and information systems students, and liberal arts students, without disabilities learn of the "lived" lives (Simon, 2013) of others with disabilities, through proper realities and representations in the disability film media, the less they might be prejudiced and the more they might be proactive in disability rights of inherently "good people" (Solomon, 2012) unnoticed in mainstream society (Shapiro, 1994), who might also be prospective information systems students. Those with or without disabilities might leverage multimedia production technologies on projects of disability storytelling (Anspach, 2013). The implication is that storytelling in the disability film media enables productive service skills of engineering and information systems students with or without disabilities in higher institutions of learning.

Another impact is that in a few instances the findings disclosed contrary depictions of improper but inadvertent misrepresentations in the disability film media of the study. These depictions were perceived by the families, fellow individuals with disabilities and staff in that focus group as negative sanitizing or stigmatizing of some of them. The implication is that storytelling in this maturing media might enable equally improper and proper realities and representations of individuals and students with disabilities that might not be filtered in existing producer standards.

A further impact is that the findings divulged proper representations in selected Hollywood mainstream media. The inclusion of individuals with disabilities as the individuals with disabilities in the mainstream media might be a prerequisite (Ross, 2013, p.5). The inclusion of disability equality sensitivity in the mainstream media involving disability media organizations and non-profit organizations for disability rights might be a specification (European Commission, 2013, p. 13). The issue of marketing media portrayals of individuals with disabilities profitably (O'Shaughnessy, 1999) might nevertheless limit progress. The implication is that the model of proper realities and representations of individuals with disabilities in the disability film media might enable proper storytelling in the mainstream media.

The final impact is that the findings from the study highlighted the requisite of self-advocacy of those with disabilities to be not only in the disability media but also in the mainstream media. From the perspective of disability media, they might be motivated to be not only disability or mainstream media performers, but even producers and technicians (European Commission, 2013, p. 27). The implication is that the disability media might be a visual storytelling success, but lacking more mainstream personnel of those with disabilities, resolution of the misrepresentations and repressions of individuals and students with disabilities in the mainstream media will not be a success.

7. LIMITATIONS AND OPPORTUNITIES

The research at a few schools and at one disability organization, having a relatively limited participant sample, limits the reach of the study. The sample of students is largely limited to a niche segregation of engineering and information systems students. The study is limited to the narrow subject of the disability media, not the broad subject of the mainstream media, in which misrepresentations of individuals with disabilities are more obvious than in the disability media. However, the disability film media might be a model for mainstream media producers on proper representations of a marginalized population, if producers are open to positive promotion (Carter-Long, 2013). Moreover, the opportunity for engineering and information systems schools, and liberal arts schools, in involving students in the fascinating field of film media for public service is a potential of this study, especially from future Disability Film Festivals at Pace University, an opportunity with guest participants for a new study.

8. CONCLUSION OF PAPER

This study evaluated the features and the impacts of the disability film media for a film festival at a major metropolitan university. The authors learned in the main that this media properly represented individuals with disabilities and their lives. Individuals with disabilities have lives like others without disabilities, but are not often perceived properly in the mainstream media. This study included focus groups of individuals with disabilities and engineering and information systems students without disabilities, in interpreting media perceptions of representations. Information systems students without disabilities, like most others without disabilities, have perceptions of individuals and students with disabilities largely through prejudiced mainstream media. They have inevitable perceptions that are not the proper realities of representations of those with disabilities and of issues of disability rights. In conclusion, this study might be a model for the mainstream media, and it will be helpful to instructors in engineering and information systems schools and liberal arts schools that hope more students might be participants, beyond their disciplinary expertise, on outward looking projects of public service involving visual storytelling technologies.

9. ACKNOWLEDGEMENTS

The authors acknowledge funding of $1,200 from the Undergraduate Student – Faculty Research Program of the Provost of Pace University.

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APPENDIX

Table 1: Evaluations of All Students without Disabilities – Summary

	Mean	**Standard Deviation**
Engagement from Features of Media		
Importance	3.47	1.63
Satisfaction	3.21	1.67
Advocacy from Features of Media		
Self-Efficacy	3.23	1.67
Sociality	3.14	1.75
Consolidated Engagement and Advocacy	3.26	1.68

Table 2: Evaluations of All Students without Disabilities – Detail

	Mean	**Standard Deviation**
Engagement and Advocacy from Features of Media		
Film 1 (*Breadmakers*)	3.98	1.27
Film 2 (*Sensory Overload*)	3.22	1.80
Film 3 (*The Interviewer*)	3.92	1.64
Film 4 (*Bystander at Grocery Store*)	3.63	1.57
Film 5 (*Life with Asperger's*)	2.91	1.47
Film 6 (*The Commute*)	3.72	1.44
Film 7 (*Miss You Can Do It*)	2.28	1.61
Film 8 (*Getting Up*)	2.97	1.60
Film 9 (*Motherly*)	2.73	1.87

Table 3: Evaluations of All Individuals with Disabilities – Summary

	Mean	**Standard Deviation**
Engagement from Features of Media		
Importance	3.79	1.60
Satisfaction	3.05	1.91
Advocacy from Features of Media		

Self-Efficacy	3.13	1.84
Sociality	3.60	1.71
Consolidated Engagement and Advocacy	3.39	1.79

Table 4: Evaluations of All Individuals with Disabilities – Detail

	Mean	**Standard Deviation**
Engagement and Advocacy from Features of Media		
Film 1 (*Breadmakers*)	3.89	1.64
Film 2 (*Sensory Overload*)	3.64	1.55
Film 3 (*The Interviewer*)	4.23	1.26
Film 4 (*Bystander at Grocery Store*)	3.44	1.85
Film 5 (*Life with Asperger's*)	2.82	2.01
Film 6 (*The Commute*)	3.35	1.87
Film 7 (*Miss You Can Do It*)	2.58	1.88
Film 8 (*Getting Up*)	3.44	1.76
Film 9 (*Motherly*)	3.16	1.71

Table 5: Evaluations of All Students without Disabilities and All Individuals with Disabilities – Summary

	Mean	**Standard Deviation**
Engagement from Features of Media		
Importance	3.64	1.62
Satisfaction	3.14	1.79
Advocacy from Features of Media		
Self-Efficacy	3.19	1.75
Sociality	3.35	1.75
Consolidated Engagement and Advocacy	3.33	1.74

Table 6: Evaluations of All Students without Disabilities and All Individuals with Disabilities – Detail

	Mean	Standard Deviation	Mean	Standard Deviation
	Importance		**Satisfaction**	
Engagement from Features of Media				
Film 1 (*Breadmakers*)	4.17	1.16	4.25	1.21
Film 2 (*Sensory Overload)*	3.66	1.63	3.25	1.80
Film 3 (*The Interviewer*)	3.51	1.76	4.40	1.06
Film 4 (*Bystander at Grocery Store*)	4.21	1.26	2.68	1.92
Film 5 (*Life with Asperger's*)	3.26	1.70	2.32	1.71
Film 6 (*The Commute*)	3.75	1.57	3.38	1.61
Film 7 (*Miss You Can Do It*)	3.08	1.69	2.09	1.77
Film 8 (*Getting Up*)	4.11	1.46	3.02	1.49
Film 9 (*Motherly*)	3.02	1.79	2.87	1.95
Advocacy from Features of Media	**Self-Efficacy**		**Sociality**	
Film 1 (*Breadmakers*)	4.06	1.51	3.53	1.67
Film 2 (*Sensory Overload)*	3.45	1.65	3.26	1.74
Film 3 (*The Interviewer*)	4.43	1.18	3.91	1.66
Film 4 (*Bystander at Grocery Store*)	3.02	1.78	4.26	1.11
Film 5 (*Life with Asperger's*)	2.53	1.71	3.36	1.62
Film 6 (*The Commute*)	3.26	1.69	3.83	1.73
Film 7 (*Miss You Can Do It*)	1.98	1.70	2.51	1.64
Film 8 (*Getting Up*)	2.98	1.49	2.62	1.92
Film 9 (*Motherly*)	2.96	1.76	2.85	1.77

Consolidated Engagement and Advocacy	**Mean**	**Standard Deviation**
Film 1 (*Breadmakers*)	4.00	1.42
Film 2 (*Sensory Overload*)	3.41	1.70
Film 3 (*The Interviewer*)	4.06	1.49
Film 4 (*Bystander at Grocery Store*)	3.54	1.70
Film 5 (*Life with Asperger's*)	2.87	1.73
Film 6 (*The Commute*)	3.56	1.66
Film 7 (*Miss You Can Do It*)	2.42	1.74
Film 8 (*Getting Up*)	3.18	1.69
Film 9 (*Motherly*)	2.92	1.81

Table 7: Model of Disability Film Festival Media Study
(Checklist Instrument is available upon request of the first author of this study.)

The Effectiveness of Data Science as a means to achieve Proficiency in Scientific Literacy

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Abstract

Data Science courses are becoming more prevalent in recent years. Increasingly more universities are offering individual courses and majors in the field of Data Science. This study evaluates data science education as a means to become proficient in scientific literacy. The results demonstrate how the educational goals of a Data Science course meet the scientific literacy criteria in regards to the process of science. Based on the commonality between data science and scientific literacy courses, the paper concludes that a data science course can be used as an alternative way for students in any major to gain scientific literacy skills.

Keywords: Data Science, Scientific Literacy, Scientific Process

1. INTRODUCTION

The amount of data produced across the globe has been increasing exponentially and continues to grow. Effectively analyzing these huge collections of data, now called Big Data, can create significant value, increasing competitiveness and delivering more value to consumers. Data science is the general analysis of Big Data. It is the comprehensive understanding of where data comes from, what data represents, and how data can be transformed into meaningful information that can be used to solve problems in diverse domains. It encompasses statistics, hypothesis testing, predictive modeling, understanding the effects of performing computations on data, and how to represent the data to others.

The goal of this paper is to study the effectiveness of data science and visualization as a means to achieve scientific literacy. By utilizing data science techniques, can students acquire competency in the area of scientific literacy? Some universities are now offering data science courses, and at least one university is now offering data science as a non-lab science course (Squire, 2012). In order to examine how effective data science can be for scientific literacy, an analysis of the learning objectives, educational goals and methodologies used in the introductory data science courses is compared to the objectives of courses that fulfill a scientific literacy requirement.

2. BACKGROUND

Data Science

There are several similar definitions for data science in the literature. Provost and Fawcett define data science as a "a set of fundamental principles that support and guide the principled extraction of information and knowledge from data." Data science involves principles, processes, and techniques for understanding phenomena via the (automated) analysis of data."

The term "data scientist" was originally coined by two data analysts working at LinkedIn and Facebook in 2008 (Davenport & Patil, 2012). While there is no consensus on the definition of data science and data scientists, there are some similarities. An article in Fortune magazine described a data scientist as a person who "helps companies make sense of the massive streams of digital information they collect every day, everything from internally generated sales reports to customer tweets." Another source, Data Scientists (2011), defined data scientists as using technology and skills "to increase awareness, clarity and direction for those working with data… Data scientists don't just present data, data scientist present data with an intelligence awareness of the consequences of presenting that data."
Many institutes of higher education are now offering degrees, certifications or courses in the area of data science. The courses are offered by different departments, including Accounting, Mathematics, Computer Science, and Information Systems. In order to understand the goals and objectives of introductory data science courses better, course syllabi from several universities were examined (Attenburg & Provost, 2012; Blumenstock, 2013; Pfister & Blitzstein, 2014; Schutt & Payel, 2013; Squire, 2012).

While the methodology and prerequisites for the introductory courses vary, there are several similarities in all of the classes. They all focus around the six steps of data science as defined by Davenport:

1. Recognize the problem or question.
2. Review previous findings
3. Model the solution and select the variables
4. Collect the data
5. Analyze the data
6. Present and act on the results. (Davenport, 2012)

In the first two steps, students determine the project scope and develop their questions and hypothesis. They research the topic and data. This step may include narrowing down initial ideas about a larger problem to one that is more defined and approachable. The modeling techniques varied between the classes depending on the level of the students.

The way the data collection step is covered varies based upon the course. Generally, sampling techniques are covered and methodologies for data capture are presented. Different tools are used to capture and mine the data, including R, python, Hadoop, web APIs and google searches. In regards to the data storage step, some of the courses discuss tools for large and small data management and storage, another course simply uses Excel for data storage.

For data preparation, munging, scraping, and/or cleaning is completed to get an informative, manageable data set. Data cleaning is the process of detecting and correcting (or removing) corrupt or inaccurate data items from a dataset. At this point, unstructured data is transformed to structured data.

At the data analysis stage, correlations and conclusions about the data are drawn. Depending on the prerequisites and emphasis of the course, the statistical depth of analysis various from simple linear regression and t-tests to basic machine learning.

The last step, data visualization and translation is the communication of information in a clear and effective way through graphical means. A number of different tools are used at this step, including Panda Visualization Tool, Python, Matplotlib, Microsoft Excel, and R.

Scientific Literacy
Scientific literacy is generally valued and acknowledged among educators as a desirable student learning outcome. Scientific literacy has received increasing attention over the years, but there is little consensus on its definition. Its meanings are drawn-out and sometimes contradictory (Laugksch, 2000). According to the National Academy of Science (1996, page 22):

"Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena. Scientific literacy entails being able to read with understanding articles about science in the popular press and to engage in social conversation about the validity of the conclusions. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately".

In order to achieve scientific literacy as described above, one must be able to understand both basic scientific information as well as the process by which science is carried out. These two aspects to scientific literacy were described by Jon D. Miller in 2007 (Ogunkola, 2013) In other words, it is not enough to memorize basic scientific information to be scientifically literate—one needs to also be able to understand how science is carried out. Each aspect of scientific literacy must be considered in more detail.

Science is the "knowledge about or study of the natural world based on facts learned through experiments and observation." (Merriam-Webster, 2014). A similar definition by the Science Council (2014) is "Science is the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence." The most significant difference between these definitions is the inclusion of social sciences in the Science Council definition. Scientific information needed for scientific literacy would include scientific terminology and concepts, potentially from both the natural and social sciences.

After extensive literature review and surveys of science faculty, Gormally, Brickman and Lutz (2012) defined two major categories of scientific literacy skills "1) skills related to organizing and analyzing the use of methods of inquiry that lead to scientific knowledge, and 2) skills related to organizing, analyzing, and interpreting quantitative data and scientific information" (p. 366). Based on responses from faculty on what skills they considered important for scientific literacy, Gormally and colleagues (2012) consolidated the responses into nine set of skills within the two categories. These skills are primarily related to the process of science.

The Scientific Process
The scientific process has been described as a set of scientific method steps. The origin of these steps as educational doctrine (beginning in the late 1800s) came from searching for a more interesting and authentic way to carry out science labs, other than simply following standardized lab procedures (Rudolph, 2005). It also arose as an alternative to rote memorization of scientific facts. One of the first proponents of the scientific method was John Dewey, who emphasized the process of knowledge construction over the knowledge itself. More recently, Rissing (2007) showed that by using the process of science students learned better and "had learned to think for themselves."

There is a range in the number of steps in the scientific method today. Commonly, there are 5 (Simon, et al., 2013; Science Made Simple, 2014) to 10 (Crooks, 1961) steps included, and these steps do not have to occur in order (Tignor, 1961). The following are five steps of the scientific method from a current introductory biology textbook (Simon, et al., 2013):

1. Observation
2. Question
3. Hypothesis
4. Prediction
5. Experiment

To begin the scientific method requires observations and questioning. During the observation step, scientists examine the world they are studying and look for anything of interest. As they observe, they write down descriptions to put their observations into words. Making observations helps them find a topic for study. By restating their observations as questions, they narrow down their observations to find individual questions to ask (often many questions) based on their observations.

The hypothesis step requires that a scientist choose only one of their questions and restate it as a hypothesis. Since the hypothesis is a testable statement, it is usually phrased such that the scientists' expected outcome is incorporated. This step is often the hardest step for a student in a science lab, for two reasons. First, they find it difficult to choose only one variable (from their questions) for their hypothesis. It takes experience to learn to evaluate each possible component of one's questions separately. Secondly, students worry about committing to a possible outcome that could be wrong. The fact that any hypothesis has value, whether it is supported or refuted, is in contrast to student experiences with assessment.

The prediction step feeds into the experiment step. Prediction is when scientists take the hypothesis and make predictions of how it could be demonstrated to begin to visualize how the hypothesis could be tested. If a scientist cannot make predictions from their hypotheses then they cannot begin to formulate a test for it. The experiment that must be done is readily revealed from the predictions. The experiment step includes both carrying out the experiment and recording the results. Some versions of the scientific method separate these components apart, and some even add a step to spell out that the experiment must be done repeatedly.

Note that another step that is often added at the end of these five steps is a sixth "conclusion" step. This conclusion step is where the scientists, based on the information gathered from the previous step, analyze and share what they discovered. The scientists will need to state whether or not the hypothesis was supported. Regardless of the result, it is during this step that the scientist try to provide meaning to the results and share their interpretation of the data with the scientific community.

3. RESULTS

In evaluating Data Science as a Scientific Literacy equivalency, it is evident that it does not always fulfill the criterion that scientific literacy include science knowledge and terminology. Data Science does include the scientific literacy criterion of the process of science, by both relatedness to the scientific method and to the skill set of scientific literacy as defined by Gormally and colleagues (2012). The comparison needed to support that statement is provided in this Results section.

The methodology used in Data Science closely matches the scientific method. First, data scientists must try to make sense of the massive amounts of data. To do this, they will begin by formulating the problem. This is where they determine the *questions* they are trying to answer with the data. Let's take for example a large national retailer with store locations throughout the United States as well as online. The data scientists may have observed that there are spikes in sales at certain times of the year. Based on this *observation*, they may question why there are spikes in sales at particular times of the year. They may even be able at this point to provide an educated guess as to what causes these spikes. This is similar to the *hypothesis* step of the scientific process.

Because there is so much data to comb through, smaller sub-sets are often created to provide a more manageable view of the data. This is done in the data collection step of data science. The retailer has customer, vendor, and transaction data flowing in and being stored 24 hours a day, 7 days a week. In order to make sense of all this data, the data scientists develop smaller sub-sets that may be comprised of regional information, type of product sales/purchases, store front or online, or even smaller by specific location. Breaking down this extensive data into subsets is similar to isolating questions by individual variables. By creating the smaller sub-sets, the data scientist is facilitated in creating appropriate hypotheses with singular variables.

After selecting a data sub-set, the data scientists go through a process of preparing the data prior to analysis. As described above, this is where they will "clean" the data. Part of the process of science is understanding whether data is valid; experimental results may not always be pure, and students should learn how to know what data should be included. From these smaller sub-sets, data scientists can begin to analyze and determine what causes shifts in the data, which is similar to a *prediction* step in the scientific method. For example, in regards to the retail industry, data scientists may find that a smaller sub-set of data points to spikes in sales corresponding with various tourist events in the location they are reviewing. The data scientist may then postulate that for all locations, spikes in data may be explained by the local events held during the year. All of the actions a student would take to this point would also fit into the first category of scientific literacy "Understand methods of inquiry that lead to scientific knowledge" category of scientific literacy skills (Gormally, *et al.*, 2012).

The next step for the data scientists would be to determine what events are held around the various other retail locations. Data scientists would then run the sales data against the local events data to determine whether or not the correlations and conclusions made with the first set of data is proven true. This could be done for all of the smaller sub-sets of data. This is similar to the *experimentation* step in the scientific method.

Finally, based on the information found in the previous steps, the data scientists would make their conclusions and present their findings. They would use techniques to translate their conclusions in a way that is clear to those who need this information to make decisions (data visualization). For the retailer, this may be showing charts that demonstrate the connection of the local events with the spike in sales data. This step is similar to a *conclusion* step in the scientific method. This second half of actions a student would take would also fit into the second scientific literacy category of "Organize, analyze, and interpret quantitative data and scientific information" category of scientific literacy skills (Gormally, *et al.*, 2012).

4. CONCLUSIONS

This example clearly demonstrates that the steps of data science parallel the steps of the scientific method. Students in data science courses are thus exposed to a similar scientific processes as those students taking natural science classes. If the purpose of using the scientific method in the classroom is to get students doing rather than memorizing, data science classes would certainly accomplish that active form of learning as well.

Scientific literacy courses are becoming more prominent in higher education (Hobson, 2008). It has been shown that students encouraged to carry out experiments using the process of science rather than follow step-by-step instructions performed much better (Rissing, 2007); Rissing specified that the improved scores reflected that students using the science process had learned to think for themselves. By using this same process in a data science course students could gain the confidence to think for themselves in other courses as well.

Data science generally deals with data taken from pre-existing data warehouses or marts whereas science courses typically derive their data through experimentation. Both types of science go through the same steps of problem solving. The process of questioning, generating a hypothesis, evaluating, processing, analyzing, and presenting the data are done similarly.

The strong parallels between data science and scientific literacy suggest that a student taking a data science course would gain the same skills of objectivity and analysis as a student in a natural science course. Therefore, whether a data science course is offered in business, computer science, or any other field, that course could fulfill student requirements for scientific literacy. This opens up alternative options for students in any major to gain the important skills of scientific literacy.

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Editor's Note:

This paper was selected for inclusion in the journal as an ISECON 2014 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 2014.

Experiential Learning using QlikView Business Intelligence Software

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Abstract

This paper reports on the use of QlikView business intelligence software for use in a Business Intelligence (BI) course within an undergraduate information systems program. The course provides students with concepts related to data warehousing, data mining, visualizations, and software tools to provide business intelligence solutions for decision making. The goal of the course is to balance both the technical and business skills students require when using business intelligence systems. Specific use of the software QlikView is outlined through an experiential project whereby students obtain, model, analyze, and interpret publicly accessible airline data. QlikView is a leading business intelligence software package that allows users to import data from a variety of sources to create visualization-based dashboards for reporting and analysis. The use of QlikView in this course addresses common challenges with using commercially available software in the classroom.

Keywords: business intelligence, data warehousing, teaching, qlikview, experiential education

1. INTRODUCTION

As technology advances and electronic data become more prevalent, organizations are accumulating data in vast quantities through a variety of means. As this electronic data grows in volume (quantity), variety (varying attributes), and velocity (pace), organizations struggle to not only maintain the data, but to make strategic decisions grounded in their electronic archives. Managers and executives are scrutinized for their decisions and fact-based data supports those decisions as opposed to "going with the gut." Business leaders need Business Intelligence (BI) for quick-and-easy access to information, to make timely and accurate decisions (Mrdalj, 2007). As BI becomes more pervasive in business, I.S. students require a different skill set. They need to understand how data is stored and be able to access and analyze it using a variety of tools (Watson, 2008). Business Intelligence makes sense of transactional and operational data while leveraging external data sources to make informed decisions about the enterprise, thereby gaining a competitive advantage through means such as increased efficiency, improved customer service, and identification of new market opportunities.

Teaching Business Intelligence to information systems students presents challenges due to its reliance upon statistics, data warehousing and databases, and other business subjects (Mrdalj, 2007). Including application-based experiences for students is an additional challenge due to the complexity of Business Intelligence software and systems. "Primary challenges professors believe they face in when teaching BI stem from a shortage of teaching resources and support. Professors who teach BI often lack: data sets, suitable cases, suitable textbooks, BI software, and technical support/training" (Wixom et al., 2011). Furthermore, the need for data sets and improved teaching resources continues to be a challenge. Professors cite the need for real-world business problems and not just rote tutorials (Wixom et al., 2014). In addition, the configuration, training, and maintenance of these systems are also time consuming from the perspective of the faculty and consequently time consuming for students to become knowledgeable enough to be productive given an infrastructure-heavy, enterprise-level BI software package.

This paper presents the use of an emerging and accessible Business Intelligence software tool, QlikView, as a means of practicing fundamental and analytical skills for information systems majors likely to assume a role in system/business analysis or data management through an active learning environment that combines both theory and practice. According to QlikView's website in August, 2014, the company boasts a customer base of 33,000 in over 100 countries (QlikTech International AB, 2014). QlikView provides an interface that encourages users to "follow the information scent" through visualization and ad-hoc querying (QlikTech International AB, 2011). The software allows students to experience organizing and managing large data sets through its in-memory technology on a desktop software platform. Due to a lower software learning curve, students are able to apply their skills with QlikView using publicly accessible data sources to solve real-world problems.

2. COURSE OBJECTIVES

Students taking this course are part of the information systems (I.S.) major that is situated within a business school curriculum. This course is an elective that supplements required courses in the I.S. major. Students in the I.S. program are grounded in the theoretical areas of programming, system analysis/design, relational databases, and networks while learning hands-on skills in both business and technology that prepare them for managing applications, data, networks, and systems in a wide variety of organizations. This course introduces and builds on the concept of data warehousing and modeling data for analysis rather than for transactional and operational processes. Most students have already had experience in modeling relational databases and writing structured query language (SQL) through previous coursework, although it is not a pre-requisite. This course provides students with a hands-on experience in data warehousing, data analytics, and executive dashboards. In addition to the experiential case discussed in this paper, students complete a series of labs focused on data warehousing fundamentals and Extract-Transform-Load (ETL) processes through Microsoft Access. These exercises build technical and modeling skills in addition to follow-up analysis of results. The course concludes with a final project where students use their BI skills to assist a community client in finding insights with their data. The primary objectives of this course are as follows:

- Understand the strategic importance of Business Intelligence and data analytics.
- Design and develop a data warehouse based on data needs and user requirements.
- Extract, transform, and load operational data into a data warehouse.
- Build a Business Intelligence application for Dashboarding, Analysis, and Reporting.
- Practice system design architecture and concepts.
- Interpret data into informed decisions for recommendation.
- Collaborate with a third-party client in teams to support organizational data needs.

3. USING QLIKVIEW FOR BUSINESS INTELLIGENCE

QlikView is a Business Intelligence software product that focuses on end-user driven Business Discovery through visualizations and data exploration (QlikTech International AB, 2011). Organizations traditionally obtain data from multiple sources that are of varying quality and use inconsistent codes that need reconciled. Integrating, cleansing and standardizing data in preparation for BI can be challenging and requires Extract-Transform-Load (ETL) tools to prepare the data efficiently (Chaudhuri, Dayal, and Narasayya, 2011). QlikView allows the user to connect to a wide array of data sources including: Microsoft Excel spreadsheets, Microsoft Access databases, text-based data files in addition to enterprise level RDBMS titles like Oracle, IBM DB2 and Microsoft SQL Server to name a few. ETL tools are built into the application through load scripts using SQL-like syntax to model and prepare the data into a fact and dimension-based data warehouse as seen below in Figure 1 (Garcia & Harmsen, 2012). While several of the dashboard creation functions within the software are "drag and drop," more advanced features require a syntax that is a blend of SQL and "Microsoft Excel-like" functions. Once the data is prepared and the model is established, the user has the capability of building dashboard applications using charts, graphs, multi-dimensional data analysis, and reports as seen in Figure 2 (Garcia & Harmsen, 2012). Hugh Watson (2008) suggests that these visual software tools are designed to be easy to use and that dashboards and scorecards are vital to an organization. QlikView's unique model is achieved through an "associative architecture" that challenges the traditional BI drill-down model shown below in Figure 3 (QlikTech International AB, 2011). This allows the user to create connections through any key-pair relationship without having to follow a traditional hierarchy of data. As a result, users can find patterns and connections quicker than through a traditional BI architecture. As of December, 2014, QlikView supports an academic program that provides free licenses of their desktop software to qualifying higher education institutions for teaching purposes. QlikView also provides training resources and an online community to share in the practice with other faculty.

In evaluating other Business Intelligence software titles for use in this course, a common challenge was higher-barriers to entry. Other popular BI software like IBM Cognos and Oracle Business Intelligence required significant server infrastructure that were not affordable or accessible despite low-cost or no-cost academic agreements. For example, the Oracle Business Intelligence stack requires separate database, middleware, and application servers, in addition to software pre-requisites such as Java and operating system patches, to run properly, all which require a significant investment of planning and time to implement (See Figure 4). Even with newer cloud-based offerings as with IBM Cognos through their academic program, a significant amount of configuration time was necessary to have an environment ready for student learning. Other open source software titles have emerged recently, such as R and RapidMiner. While these tools were easy to obtain and install, they required a significant amount of training time, which took away from BI fundamentals. QlikView's main competitors that offer similar products are Tableau and Spotfire. At the time of course preparation, neither company offered academic licenses, but have since launched similar programs as QlikView. Wixom et. al. (2014) reports that the number of professors who leverage academic alliance resources has increased, however, there remains a demand for stronger teaching resources.

QlikView's desktop edition requires a small computer laboratory footprint, which allowed for faster setup time for the course. The software installed using a traditional installation wizard that took no more than 10 minutes per workstation. QlikView provides several free resources including videos and downloadable tutorials that allow students to learn, self-guided, on how to use the software application. Supplemental tutorials were used from "QlikView for Developers" by Miguel Garcia to build a more robust skill set beyond the beginner level and provide a connection between Business Intelligence principles and a new model for data analysis. In addition, QlikView allows for the processing of millions of rows of data using in-memory technology. This scalability allows for the introduction of Big Data concepts on a consistent platform for students. The software allows for the teaching of fundamental BI concepts such as ETL and Data Warehousing, but has a look toward the emerging trends in business intelligence with regards to Big Data. Another goal that was achieved through selecting QlikView is that it was built with the knowledge worker in mind rather than the programmer. This allowed the focus of the course to be on how to model, analyze, and interpret the data rather than overcoming software-specific hurdles. While the course is currently aimed at information systems majors, it could be amended to appeal to a wider business school or non-business school audience.

4. USING AIRLINE DATA TO APPLY BI SKILLS

To gain a better understanding of QlikView beyond tutorials and prescribed lab exercises, students are given a case and tasked with determining factors that lead to delayed commercial airline flights. The premise is that a popular travel publication wants to assist its readers in how best to choose flights that have a higher probability of being on-time. Objectives for this case are to: 1) obtain data from an external source, 2) model the data in the form of a data warehouse, 3) construct dashboards for analysis and reporting, and 4) analyze and interpret the results.

Students obtain publicly available airline data from the Research and Innovative Technology Administration website (http://www.transtats.bts.gov/DL_SelectFields.asp?Table_ID=236&DB_Short_Name=On-Time). The site contains departure and arrival data for domestic commercial airline travel for a given date range. The data can be downloaded in comma-separated value (CSV) files along with corresponding look-up tables. Students are challenged with sifting through an external data source that contains several attributes classified in different manners, in addition to approximately 500,000 rows of data per month. Through this case, students learn how to handle large data sets and are simultaneously challenged with addressing uncertainty in the way of data quality.

Once students have the data set downloaded, the data is modeled into a star-schema data warehouse for import into QlikView. Students use the provided data set and make decisions on how to align the data appropriately for analysis. Students then prepare for the extract-transform-load (ETL) process using QlikView's load script feature. The load script is a text-based editor that includes a "builder-like" feature to allow the construction of load statement (See Figure 5). Through this process, students practice ETL skills to convert data into appropriate data types and transform data into appropriate fact-based and time-variant dimensions.

Once the data is transformed and loaded into QlikView, students build visualizations to represent the airline data in a myriad of ways, from charts and graphs to gauges and multi-dimensional data tables. This process allows students to go beyond obtaining and modeling data, but to critically think about how best to represent the data for analysis. Once the dashboards are complete, students then summarize their findings in a business-style report for the travel publication.

"A BI recruiter noted that [It's hard to find] a good mix of technical and business skills. Too often, students are skewed too far one way or the other" (Wixom, 2011). This experiential project allows students to see the whole process from beginning to end while practicing with relevant data. In a student survey regarding the airline project, one student commented that they "learned that it was more efficient to transform data in QlikView as opposed to other well-known tools like Microsoft Excel and Access." Another student said that "it helped [him] understand that it was I.T.'s job to build and model data so that others in the company can make better decisions." One student reflected on the importance of ethics and critical thinking by saying, "the developer has the opportunity to make the data say what [he/she] wants. It reinforced the need for me to be unbiased and think about how I wanted to display the data." Based on Kolb's research in experiential learning, the experience provided students with opportunities for a concrete experience, abstract conceptualization, active experimentation, and reflection (1984). This assignment moved students from completing a list of prescribed steps to simulating real-world work; work they are now better prepared to execute after graduation. Wixom et. al's (2014) work concludes that through real-world business problems, students can be better prepared to "hit the ground running". Through this exercise, students apply their knowledge of data warehousing concepts in a technical setting through QlikView using real data while interpreting and reflecting upon their creation.

5. DISCUSSION AND CONCLUSIONS

The details of this paper make an important contribution to information systems educators in search of a low-maintenance, no-cost, low-learning curve software package that allows students to demonstrate the practice of data warehousing in combination with data analysis. The airline data exercise allows students to build on their learned BI skills with a real-world data set that goes beyond a software demonstration or step-by-step set of instructions. Course evaluations indicated that students found the software tool valuable in developing their ability to build data warehouses and create BI applications using real-world data. Because the software has lower barriers to entry and has a lower learning curve than infrastructure-heavy enterprise software packages, it is possible that this course could be made available for other business majors where analyzing and interpreting data for competitive advantage are valuable skills, such as in the disciplines of finance and marketing. Further work is necessary to evaluate the format of the course, analyze appropriate pre-requisites, and evaluate how it can be best delivered to a broader audience.

6. ENDNOTES

1. This paper focuses on the QlikView desktop edition which comes as a downloadable software application for either Windows 32-bit or 64-bit architectures. The program is installed on individual machines running Microsoft Windows 7 (support for Microsoft Windows 8 is available). There were no software conflicts or maintenance issues encountered once the software was installed. A free-trial is available at http://www.qlikview.com, although QlikView application files developed on the installed workstation will be invalid

on other workstations. Each student had their own workstation in a computer lab for use of assignments and projects.

2. This class has been taught in the aforementioned format for two years in the spring. The average number of students in this class is 9 per offering. The only pre-requisite for this course is Organizational Information Systems, a survey information systems course that all business majors take.

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Appendix A

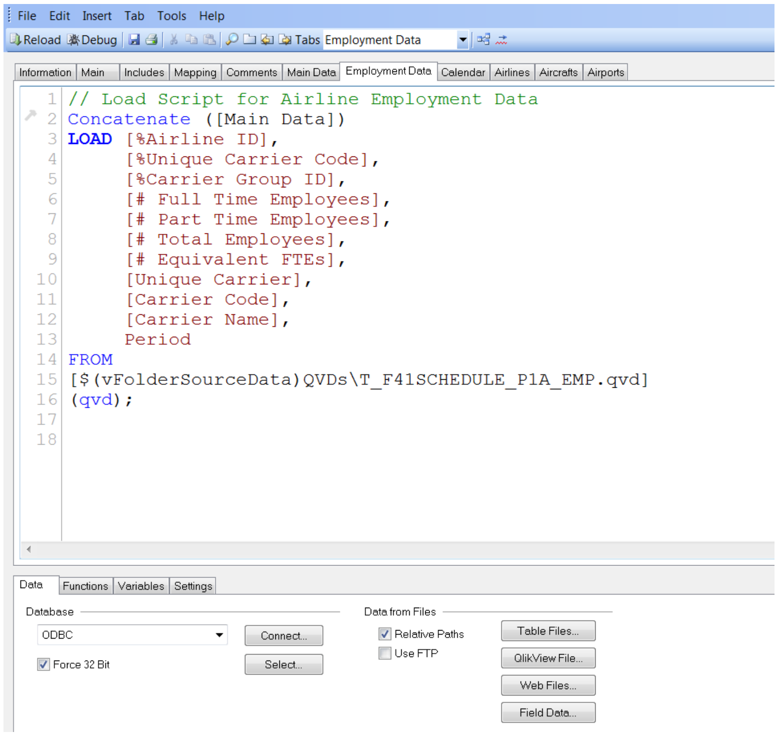

Figure 1: QlikView Load Script Window

Figure 2: QlikView Application Dashboard

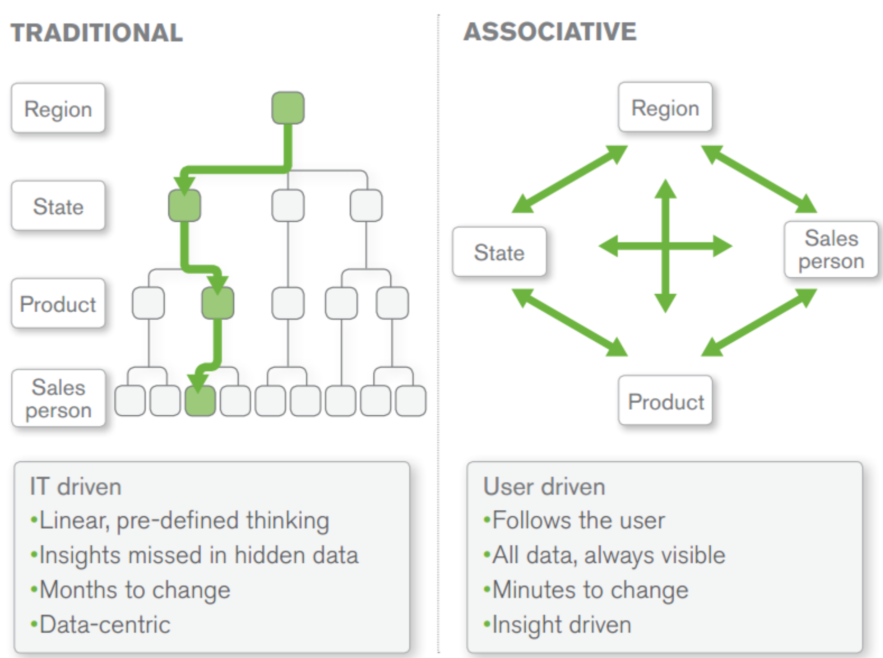

Figure 3: QlikView's Associative Architecture

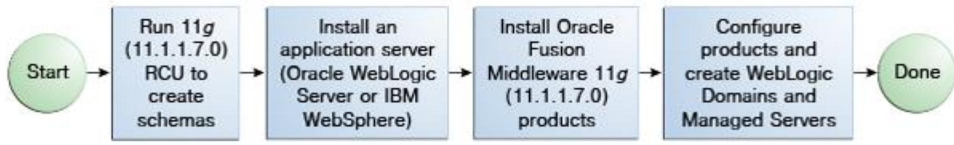

Figure 4: Installing Oracle Business Intelligence Release 11.1.1.7.0 Using the Product Installer

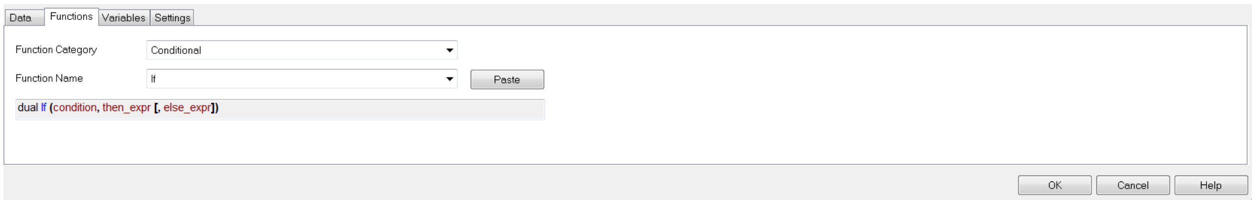

Figure 5: QlikView Expression Builder

Appendix B
Airline Analysis in QlikView

Background

Commercial airlines are constantly under scrutiny from the government and the public for the timeliness in takeoff and departure. The popular periodical *Travel and Leisure* has contracted you to build a business intelligence application to analyze the timeliness (or lack thereof) of domestic commercial airlines. They want to inform their readers of the best and worst carriers based on timeliness. *Travel and Leisure* is particularly interested to see if there are differences based on location and/or time (time of day, week, month, etc.) They would like to publish your findings in their upcoming issue. Your goal is to develop an appropriate data warehouse model and create a business intelligence application using QlikView to support the analysis of domestic commercial airline departure and arrival data from October through December, 2013.

Access to Data

Access to the appropriate data can be downloaded from the following website via the Research and Innovative Technology Administration: http://goo.gl/a1rnk. This table contains on-time arrival data for non-stop domestic flights by major air carriers, and provides such additional items as departure and arrival delays, origin and destination airports, flight numbers, scheduled and actual departure and arrival times, cancelled or diverted flights, taxi-out and taxi-in times, air time, and non-stop distance.

The website allows you to select which fields you want to download in your table. Definitions for those fields are available as well. Associated fields also contain necessary lookup tables to build your data warehouse using varying dimensions. All of the data from this source is downloadable in csv (comma separated value) format. You will need to import and transform that data to build your fact and dimension tables for use in your QlikView application.

Requirements and Evaluation (75 points)

Through this project, you should be able to demonstrate the following:

- Ability to access data from public sources in raw format and import into QlikView. (5 points)
- Model an appropriate data warehouse using necessary facts and dimensions using a star schema approach. (20 points)
- Transform data into the appropriate format for use in analysis. (5 points)
- Develop a business intelligence application using QlikView that consists of appropriate charts, graphs, and tables that enables users to engage in business discovery for *dashboarding, analysis, and reporting*. (25 points)
- Analyze the data through the developed QlikView application.
- Articulate the insights and conclusions that can be made in a 2-3 page summary report that can be submitted to your client, *Travel and Leisure.* (20 points)

Appendix C
Book Resources for Educators

1. *Business Intelligence (Strategic Management Collection)* by Jerzy Surma. 2011. Business Expert Press. ISBN-13: 978-1606491850

2. *QlikView for Developers* by Barry Harmsen and Miguel Garcia. 2012. Packt Publishing. ISBN-13: 978-1849686068

3. *QlikView for Developers Cookbook* by Stephen Redmond. 2013. Packt Publishing. ISBN-13: 978-1782179733

Appendix D
Website Resources for Educators

1. QlikView Academic Program: http://www.qlik.com/us/company/academic-program

2. QlikView Software Download: http://us-d.demo.qlik.com/download/

3. QlikView Resource Library: http://www.qlik.com/us/explore/resources

4. Research and Innovative Technology Administration Airline Data Download: http://www.transtats.bts.gov/DL_SelectFields.asp?Table_ID=236&DB_Short_Name=On-Time

Addressing the 21st Century Paradox: Integrating Entrepreneurship in the Computer Information Systems Curriculum

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Abstract

The Computer Information Systems (CIS) discipline faces an identity crisis: although demand for CIS graduates is growing, student enrollment is either in decline, or is at least soft or flat in many cases. This has been referred to as the 21st century paradox. As one solution to this problem, we propose to integrate entrepreneurship in the CIS curriculum. An analysis of N = 253 universities in the United States finds that only 39.5% offer both CIS and entrepreneurship degrees. Large, private, research-oriented universities were found to be most likely to offer both degrees. A follow-up qualitative analysis of eight ABET accredited IS programs in business schools that also offer a full-time entrepreneurship degree finds that only one university gives students the option to take one entrepreneurship class as part of their IS major. We propose to infuse entrepreneurship in CIS classes based on the lean startup methodology and offer a learn-build-measure feedback loop, along with open source software and agile development practices, as a pedagogical framework for instructors. The paper concludes with a discussion of how entrepreneurship in the CIS curriculum creates graduates that are better prepared to enter the job market.

Keywords: 21st century paradox, ABET, entrepreneurship, lean startup, learn-build-measure feedback loop

1. INTRODUCTION

Enrollment in CIS is down and/or flat for many programs. Either students are not interested in CIS, our core competency has been encroached by software engineering, or we have failed to maintain our relevance; these are some of the problems faced by our discipline. At the same time, employer demand for both the technical and inter-personal/organizational qualities that a CIS graduate possesses is strong and growing (BLS, 2014). We believe that among the possible solutions available for some CIS programs facing the 21st century paradox (Burns, et al., 2014) could be to consider integration of entrepreneurship in the CIS curriculum or at least adopting its perspective. This would not merely be for the purposes of suggesting that the entrepreneurship path is one that would be successfully pursued by all of our graduates, but rather that beyond the feasibility of such success is a perspective and "lens" through which the CIS discipline can be seen from pedagogy in the academy, practice in the field, and research.

For the purpose of this work, we define entrepreneurship as "an individual’s ability to turn ideas into action" (Commission of the European Communities, 2006, n.p.). As such, entrepreneurship includes creativity, innovation, risk taking, and the ability to plan and manage projects in order to achieve objectives. Entrepreneurship also implies a sense of self-organization and leadership. In addition to providing a foundation for entrepreneurs wishing to establish a social or commercial activity, this view of entrepreneurship also helps people in their day-to-day life at home, as citizens, and as employees by making them more aware of the context of their work. In fact, entrepreneurship has been identified as one of eight key competencies necessary for personal fulfillment, social inclusion, active citizenship, and employability identified Education & Training 2010 Work Programme (European Parliament, 2006). The propositions regarding entrepreneurship and CIS in this paper are directly aligned with a recent call by the European Commission for universities to "integrate entrepreneurship as an important part of the curriculum, spread across different subjects, and require or encourage students to take entrepreneurship courses." (Commission of the European Communities, 2006, n.p.) This call seems equally applicable for universities elsewhere, including those in the US.

Given the wide-ranging benefits of entrepreneurship, we are interested in the following research questions:

- What are established methodologies to foster entrepreneurship?
- What aspects of the CIS curriculum and discipline are amenable to an entrepreneurship perspective?
- What is the state of cross-curriculum collaboration and integration of entrepreneurship and CIS in the United States?
- How can schools integrate entrepreneurship in the CIS curriculum?

This paper proceeds as follows. First, we describe the lean startup: a popular methodology to foster entrepreneurship. Next, we use aspects of model curricula to propose where entrepreneurship "fits" with the CIS curriculum. Then, we describe the methods used to assess the state of cross-curriculum collaboration between entrepreneurship and CIS in the United States. Section four presents the results, followed by a set of recommendations on how schools can integrate entrepreneurship in the CIS curriculum. We conclude with ideas and propositions of how entrepreneurship enhances the CIS discipline.

2. THE LEAN STARTUP MOVEMENT

Previous research suggests that business opportunities are created rather than discovered (Alvarez & Barney, 2007). Specifically, the process of creating a business opportunity is best thought of as an incremental, iterative cycle of action and learning in which the entrepreneur engages with potential customers to co-create a business opportunity (Prahalad and Ramaswamy, 2004). In line with this theory, a recent set of practices subsumed under the umbrella term "lean startup" has emerged in the field of technology entrepreneurship. The principles of the lean startup methodology are largely based on insights drawn from information technology startups, particularly in a business-to-business context.

Lean startup is a prescriptive methodology aimed at reducing the amount of waste in startups (Ries, 2011). The lean startup methodology views a startup as a temporary organization designed to search for a repeatable and scalable business model. A business model, in turn, describes how an organization creates, delivers, and captures value. Thus, any activity that does not directly contribute to the search for a business model is considered waste. In contrast to the traditional trilogy of information systems development - which focuses to deliver on time, on budget, and to specifications - the key challenge for a startup is to build something that people (i.e. customers) want. At the core, the lean startup methodology recognizes that startups are different from companies: whereas the primary focus of a company is to execute an established business model, a startup's goal is to search for a viable business model. Whereas IT departments in traditional companies usually solve a known problem for a product owner or in-house customer, a startup solves an unknown problem for an unknown customer. Although the lean startup methodology is not written in stone, the build-measure-learn cycle, agile development, and the use of open source software have emerged as its core practices over the past few years.

The "lean" in lean startup is not new and is an extension of the metaphor into the area of entrepreneurship from its origins in manufacturing, supply-chain, business process optimization, and software development (George & George, 2003; Holweg, 2007; Naylor et al., 1999; Poppendieck & Poppendieck, 2003). Furthermore, lean is often included in the family of agile software development models, methods, and practices (Dybå & Dingsøyr, 2008). That the "lean" metaphor extends well into organizational issues, technical issues, and those related to the design, implementation, and upkeep of information systems bodes well for the lean metaphor both as a means of understanding entrepreneurship and its application to CIS.

In contrast to the profit motive of established companies, the goal of a lean startup is to gain validated learning about customers (Ries, 2011). What matters most to a lean startup is not to generate revenue, but to prove the viability of its business model. Of course, part of the viability of the business model concerns revenues, especially the unit economics of their business (e.g. customer acquisition costs, expected revenue per customer, etc.). Ries (2011) proposes that the most efficient and effective way to achieve validated learning about customers is to quickly and iteratively engage in a feedback loop of "build-measure-learn" (see Figure 1).

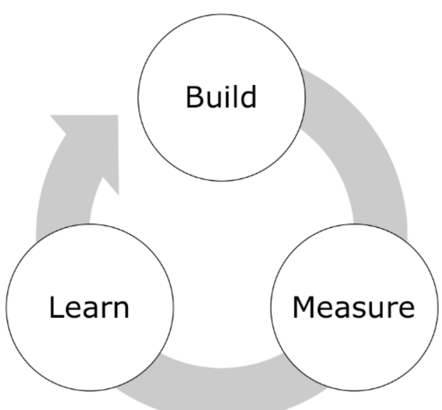

Figure 1: The build-measure-learn feedback loop in a lean startup (Ries, 2011)

Starting with a strong founder's vision about the customer's problem or need, a lean startup begins to build a so-called "minimum viable product" (MVP), with the goal of gaining as much validated learning about the customer as possible. An MVP "[...] is that version of the product that enables a full turn of the build-measure-learn loop with a minimum amount of effort and the least amount of development time" (Ries, 2011, p. 82). MVPs can be landing pages, wireframes, or other simple prototypes that lack many of the features of a full-blown product. What is most important about the MVP is its ability to gather validated learning about customers. In the second stage, measure, the MVP must be put in front of customers to elicit qualitative feedback and/or quantitative measurement of customer behavior. Lastly, in the learn phase, the startup must evaluate the data gathered from the measure stage and decide whether to pivot or persevere. In the learn startup methodology, a pivot refers to a fundamental change in the business model of the startup.

3. THE LEAN STARTUP IN THE CIS CONTEXT

In the Information Technology and Information Systems context, the rapid and iterative development of an MVP is best (and typically) accomplished through agile software development practices. Agile development is best thought of as a set of systems development principles or values. These principles include (Beck et al., 2001):

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

One popular agile development framework is Scrum (Schwaber & Sutherland, 2013). In Scrum, a product owner creates a prioritized wish list of features, called a "product backlog." The development team then plans a "sprint", which is a pre-defined time of work (usually lasting one week to one month), during which some of the features in the product backlog are moved in the "sprint backlog," to be worked on during the sprint. Every day the team meets briefly to assess its progress and discuss challenges in a so-called daily scrum. The scrum master is responsible for keeping the team on track so that at the end of the sprint a working piece of software is ready to be released. As the next sprint begins, the team decides again which features to move from the product backlog to the sprint backlog. Using an agile development methodology, like scrum, enables software developers to iteratively develop an MVP in a relatively short amount of time.

Lastly, technology startups tend to rely on open source software when creating their MVPs. In addition to open source software being free of charge, a large and growing community of open source contributors and developers serve as a global helpdesk in case of questions or problems. Examples of such open source software include the LAMP stack (Linux, Apache, MySQL, PHP) as well as web development frameworks such as Ruby on Rails (Ruby), Django (Python), and Meteor, Node.js, Angular (JavaScript), as well as various HTML5/CSS3/JavaScript front-end frameworks such as Boilerplate and Bootstrap. These tools have been created with agile development practices in mind and are thus ideally suited for the rapid development of MVPs. Together with the build-measure-learn feedback loop and agile development, open source software forms the technological basis for the lean startup methodology.

As of this writing, it does not appear that the lean startup methodology has been systematically studied and validated, in an empirical sense. The phenomenon is largely focused on nascent success found in business-to-business technology startups. Nevertheless, it appears that a set of practices that focus on customer-centered, iterative development seem to have taken hold in practice in a compelling way. We believe that the CIS discipline is uniquely positioned to teach/infuse most of these practices in its curriculum. In the next section, we describe the methods used to assess state of cross-curriculum collaboration and integration of entrepreneurship and CIS in the United States.

4. THE NATURE OF THE CIS CURRICULUM AND THE FIT FOR ENTREPRENEURSHIP

It is also important to understand the Information Systems discipline in order to see how and why lean entrepreneurship provides a particular metaphorical and analogous lens through which we can understand future possibilities for the application of information systems with respect to the 21st Century Paradox (Burns, et al., 2014).

Information Systems (IS) is a computing discipline, among the spectrum of computing disciplines, which addresses the problem space of computing in a unique manner. Figure 1 reflects a proposal for the IS domain within the computing problem space (Shackleford et al., 2006).

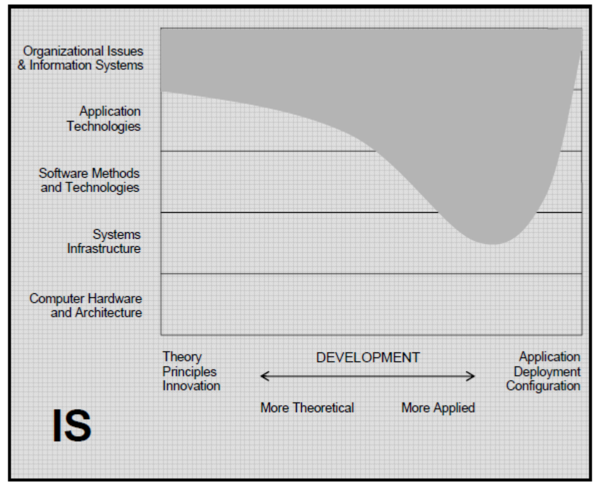

Figure 2: Information systems in the problem space of computing (Shackleford et al, 2006)

Information system (IS) has been characterized as a discipline which involves an applied understanding of the nexus between hardware and software, used by individuals and organizations to exchange data and information for goal-driven purposes (Checkland et al., 1997; Valacich et al., 2014). IS has evolved as an inter-disciplinary endeavor where, from the position of computing, it fully engages the "edge case" of organizational issues and application areas of computing (see Figure 2). It is possible then to characterize IS as a facet of computing that is "in service to" societal and organizational issues and needs, where the design, development, delivery, maintenance, and oversight of evolution of information systems is a key focus. In some degree or proportion, we are multi- and inter-disciplinary and "serve" several masters. Of course this assertion is not without controversy and debate. That is, IS is not pursued, conceived of, or implemented uniformly. IS can be interpreted in favor of a focus on the organizational impacts of IT artifacts such that the organizational issues are at the core of study and concern. It has been suggested that this perspective would refer to the discipline as Management Information Systems (MIS). On the other hand, some see the discipline as being firmly rooted in the technical, often referring to the discipline as Computer Information Systems (CIS). In terms of how this distinction influences programs of study in IS, the following is offered: "…programs in Computer Information Systems usually have the strongest technology focus, while programs in Management Information Systems emphasize the organizational and behavioral aspects of IS." (Shackleford et al., 2006) We characterize this distinction as it may impact the means by which a program chooses to implement aspects of entrepreneurship, particularly from the lean startup perspective. While possibilities exist from both ends of the IS "spectrum," many of our assumptions are based from the perspective of programs which lean more towards CIS. Nevertheless, we recognize that the terms CIS, MIS, and IS may have different meanings across schools. Thus, we use the term CIS in an encompassing sense, meant to cover CIS, MIS, and IS programs across the entire spectrum of the discipline.

5. METHODS

In order to understand the state of cross-curriculum collaboration and integration of entrepreneurship and CIS, we first had to develop a comprehensive list of universities offering a CIS degree. To do so, we searched the membership directories of both AACSB and ABET. We found a total of 239 AACSB accredited business schools offering a full time undergraduate CIS degree in the United States. A total of 28 universities offer ABET accredited information systems programs in the United States. Fourteen universities are both AACSB and ABET accredited, leaving a total N = 253. We then used data provided by AACSB (for accredited schools) and the university websites to determine if a university offers a full-time entrepreneurship degree or major. In addition, we were interested in understanding potential factors associated with a university offering both CIS and entrepreneurship degrees. For one, we noted whether or not a university is private or public. Next, we used the Carnegie Classification of Institutions of Higher Education to classify if a university is predominantly research-oriented (i.e. doctoral/research university, research university with high research activity, or research university with very high research activity). Lastly, we recorded the number of full time undergraduate students enrolled in the business school as a proxy for university size.
Next, we conducted multiple two-sample t-tests to understand statistically significant differences between the group of universities that only offer a CIS degree and the group of universities that offer both CIS and entrepreneurship degrees. To conduct the t-tests, we recorded whether or not a university is private (0 = no, 1 = yes), whether or not a university is a research university (0 = no, 1 = yes), and the number of full time students enrolled in the business school.

Based on this analysis, we selected a small group of universities (N = 8) that offer an ABET accredited program in information systems and that also offer a full-time entrepreneurship degree. For this group, we then accessed the university websites in order to investigate the apparent collaboration between CIS and entrepreneurship in terms of cross-curricular offerings.

6. RESULTS

Out of 253 universities offering a CIS degree, 100 (39.5%) also offer an entrepreneurship degree. Out of these 100, 97% are AACSB accredited, 8% are ABET accredited, and 5% are accredited by both AACSB and ABET. Universities offering both a CIS degree and an entrepreneurship degree (Group 1) are significantly more likely to be private than universities offering only a CIS degree (Group 2) (M_1 = .28, M_2 = .17, t = 2.03, $p < .05$). Moreover, universities offering both a CIS degree and an entrepreneurship degree are significantly more likely to be research universities than universities offering only a CIS degree (M_1 = .55, M_2 = .42, t = 1.97, p = .05). In addition, universities offering both a CIS degree and an entrepreneurship degree are significantly larger – as measured by the number of full-time students enrolled in the business school – than universities offering only a CIS degree (M_1 = 2148.05, M_2 = 1659.20, t = 2.82, $p < .01$). Lastly, universities offering both a CIS degree and an entrepreneurship degree are just as likely to be AACSB or ABET accredited than universities offering only a CIS degree (AACSB: M_1 = .97, M_2 = .93, t = 1.32, $p > .1$; ABET: M_1 = .08, M_2 = .13, t = 1.56, $p > .1$). In other words, large, private, research-oriented universities are likely to offer an entrepreneurship degree in addition to a CIS degree.

We found a total of eight universities offering an ABET accredited information systems degree while also offering a full time entrepreneurship degree. These universities include:

- Drexel University
- James Madison University
- Quinnipiac University

- Radford University
- Rowan University
- University of Houston
- University of Nebraska at Omaha
- University of Tampa

Additional information about each university can be found in Table 1 (see Appendix). A closer investigation of the CIS programs at these universities indicates that none includes an entrepreneurship course as part of the required classes. Only Drexel University gives students the option to take an entrepreneurship class as an elective in their CIS degree (see Table 2 in Appendix).

At Drexel University, the MIS major consists of 24 credits (6 x 4 credit courses), including 8 credits (2 x 4 credit courses) of MIS electives. Students may choose any two from a list of five MIS electives, including one entrepreneurship class: "Business Plan for Entrepreneurs" (MGMT 365). According to the course description, "[i]n this course, students learn how to prepare a comprehensive strategy for launching a new business. The vehicle for achieving this is the preparation of a start-up business plan based on a selected opportunity" (Drexel University, 2014). Thus, MIS students at Drexel University may take one dedicated entrepreneurship course as part of their major.

Clearly, entrepreneurship is not part of the CIS curriculum at most universities. However, it is also possible to bring entrepreneurship and entrepreneurial thinking into "traditional" CIS classes. The following section describes ideas and recommendations for an integration of entrepreneurship in core CIS classes, based on the ABET criteria for accrediting computing programs.

7. RECOMMENDATIONS

Based on the results of our study, it is clear that entrepreneurship is currently not part of the CIS curriculum – at least not at schools which offer an ABET accredited full-time CIS degree and a full-time entrepreneurship degree. Thus, for schools offering entrepreneurship classes, we suggest considering adding those classes to the list of eligible CIS electives. We use ABET as a filter as ABET is thought to hold consistent guidelines for the discipline for the past 10 years.

According to the criteria for accrediting computing programs 2014-2015 (ABET, 2014), information systems programs must have one year of course work that includes "coverage of the fundamentals of a modern programming language, data management, networking and data communications, systems analysis and design and the role of Information Systems in organizations" as well as "advanced course work that builds on the fundamental course work to provide depth." Whereas ABET provides guidelines with regards to the content of what to teach, the lean startup methodology may be used for insights with regards to how to teach and instill an entrepreneurial mindset in students.

As described above, the lean startup methodology consists of a set of practices, including the build-measure learn feedback loop, agile development, and the use of open source software. We suggest adapting the learn startup methodology in CIS classes in order to help students achieve validated learning about technical concepts. Recall that a lean startup aims to achieve validated learning about customers by quickly and iteratively cycling through the build-measure-learn feedback loop. We believe that a student in a CIS class can achieve validated learning about technical concepts by quickly iterating through a learn-build-measure feedback loop (see Figure 3). The learn-build-measure feedback loop recognizes that students need to first learn the skills necessary to build something (like an MVP).

First, students must learn how to build whatever they will build in the next phase. This could be something simple, like a wireframe, or something more complex, like a website. In either case, it is crucial that the instructor creates a learning environment (including learning materials and exercises) that prepares students for the next phase. Moreover, to foster entrepreneurial thinking, students should be given the freedom to choose what they want to build – in collaboration with the instructor. Also, students should explore the problem space for which they will build a solution. As part of that exploration, students should establish ways to validate their learning. In other words, students should identify ways to put what they will build in front of actual customers. Pedagogical techniques for independent learning, like the flipped classroom model (Frydenberg, 2012), can be used to allow student to learn at their own pace.

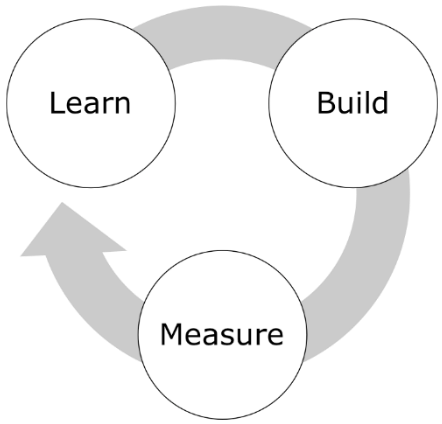

Figure 3: The proposed learn-build-measure feedback loop in CIS education

Next, students engage in building. Given that this phase tends to be the most technically complicated of the three, it makes sense to have students build in class. As such, class time becomes more like a workshop or lab, in which the instructor works with students one-on-one to solve issues they might encounter. In line with the lean startup methodology, students should make use of open source software and engage in agile development practices.

Lastly, students measure what they have built via customer responses in the form of verbal, written, or behavioral feedback. Depending on the class, customers might be students outside of class, other faculty, administrators, or people outside the university. The point here is to get students to receive feedback from outside the class. Based on the feedback, students then decide if and how to persevere or pivot. Ideally, students will be able to iterate several times through the learn-build-measure feedback loop over the course of a semester. At the end of the semester, the instructor can assess the validated learning achieved through the customer feedback and the artifacts created in the process.

We believe that by implementing a learn-build-measure feedback loop in CIS classes, instructors would help students attain a number of valuable skills and abilities. In particular, we propose that the top three skills fostered by a learn-build-measure feedback loop, are (from the list of student outcomes (a) through (i), ABET, 2014):

- An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs;
- An ability to use current techniques, skills, and tools necessary for computing practice;
- An ability to communicate effectively with a range of audiences.

The first student outcome is directly addressed in the build phase of the learn-build-measure feedback loop. To accomplish said outcome, it is crucial that students engage in the development of actual information technology artifacts, such as wireframes, prototypes, and other forms of MVPs. Similarly to the first student outcome, the second student outcome is also covered in the build phase. By engaging in agile development coupled with the use of open source software, students learn and apply systems development as it is practiced in many technology startups today. Finally, the third student outcome is addressed in the measure phase. As students engage with potential customers and other stakeholders to receive feedback on their artifacts, they communicate with various constituents that have varying backgrounds and levels of technical knowledge.

As such, we feel that a focus on entrepreneurship in the form of entrepreneurship classes and/or a learn-build-measure approach to CIS education will not only help students become entrepreneurs, but also help students be better prepared to enter the workforce with a set of practical skills that are equally applicable in information technology positions at large organizations.

Certainly further research is needed to test the efficacy of entrepreneurship classes in a CIS curriculum and our proposed learn-build-measure feedback loop in CIS education. One potential downside of such a hands-on, practical approach to CIS education is a potential lack of theoretical knowledge gained by students. Also, by focusing so strongly on building something like an MVP, students will become skilled in a particular programming language or application, which might or might not be part of their career in the future. In addition, it is possible that similar pedagogical practices are already in use at CIS programs without our knowledge. However, a hybrid approach which blends learn-build-measure with more traditional approaches, which may favor theory, can be explored. Eventually, particularly in the case of ABET-accredited programs, some room is left to define and design a blend of upper-level coursework to augment or complement the learn-build-measure approach.

8. CONCLUSION

In this paper, we explore the potential of entrepreneurship to help CIS overcome the 21st century paradox of declining enrollment and growing employer demand (Burns, et al., 2014). In particular, we analyze the extent to which entrepreneurship classes are part of the CIS curriculum in ABET accredited IS programs. We find that, among schools that offer ABET accredited IS programs and full-time entrepreneurship programs, only one university offers students the option to take one entrepreneurship class as part of the CIS major. Next, we propose to infuse entrepreneurial practices based on the lean startup methodology in CIS classes. We offer a learn-build-measure feedback loop, along with open source software and agile development practices, as a pedagogical framework to guide instructors wishing to incorporate the lean startup methodology in their classes.

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Appendix

Table 1: ABET accredited IS programs in schools offering a full-time entrepreneurship degree

School	Location	AACSB	Private	Research university	Enrollment
Drexel University, Bennett S. LeBow College of Business	Philadelphia, PA	Yes	Yes	Yes	2,879
James Madison University, College of Business	Harrisonburg, VA	Yes	No	No	3,101
Quinnipiac University, School of Business	Hamden, CT	Yes	Yes	No	1,495
Radford University, College of Business and Economics	Radford, VA	No	No	No	1,329
Rowan University, Rohrer College of Business	Glassboro, NJ	No	No	No	924
University of Houston, C.T. Bauer College of Business	Houston, TX	No	No	Yes	3,412
University of Nebraska at Omaha, College of Business Administration	Omaha, NE	No	No	Yes	NA
University of Tampa, John H. Sykes College of Business	Tampa, FL	Yes	Yes	No	1,565

Table 2: Curricula of selected programs

University (Degree)	Required courses in major	Entrepreneurship electives
Drexel University (Bachelor of Science in Business Administration, Major in MIS)	1. Systems Analysis and Design 2. Database Design and Implementation 3. Management Information Systems Strategy 4. Domestic and Global Outsourcing Management + 2 major electives	1. Introduction to Entrepreneurship 2. Business Plan for Entrepreneurs
James Madison University (Bachelor of Business Administration in CIS)	1. Principles of Programming 2. Operating Systems and Server Administration 3. Enterprise Architecture 4. Computing and Telecommunications Networks 5. Database Design and Application 6. Intermediate Computer Programming 7. Systems Analysis and Design 8. Information Systems Development and Implementation + 2 major electives	[None]
Quinnipiac University (Bachelor of Science in CIS)	1. Systems Analysis & Design 2. Object-Oriented Analysis & Design 3. Object-Oriented Programming 4. Enterprise Systems 5. Networking & Data Communications 6. Database Programming & Design 7. IT Project Management 8. Information Systems Internship + 2 major electives	[None]

University (Degree)	Required courses in major	Entrepreneurship electives
Radford University (Bachelor of Science in Information Science and Systems)	1. Principles of Information Technology 2. Principles of Computer Science I 3. Principles of Computer Science II 4. Web Programming I 5. Introduction to Information Security 6. Data Management and Analysis with Spreadsheets 7. Database I 8. Software Engineering I 9. Decision Support Systems 10. Senior Seminar 11. Information Science and Systems Capstone [No major elective]	[None]
Rowan University (Bachelor of Science in MIS)	1. Principles of Systems Design 2. Business Systems 3. Design of Database Systems 4. Advanced Database Management 5. Network Management 6. Business Web Applications 7. Project Management 8. Managing International Business 9. E-Business: IS Perspective 10. Enterprise Computing II 11. MIS Capstone Experience [No major elective]	[None]
University of Houston (Bachelor of Business Administration in MIS)	1. Systems Analysis and Design 2. IS Tools 3. Transaction Processing I 4. Database Management I 5. IT Project Management 6. MIS Management and Lab + 2 major electives	[None]
University of Nebraska at Omaha (Bachelor of Science in MIS)	1. Introduction to Personal Computing 2. Introduction to Computer Programming 3. Introduction to Computer Science II 4. Organizations, Applications, and Technology 5. Introduction to Applied Statistics for IS&T 6. IT Ethics 7. File Structures for Information Systems 8. Managing the Data Base Environment 9. Business Data Communications 10. Managing in the Digital World 11. Intro to Project Management 12. Information Systems Analysis 13. Systems Design and Implementation + 4 major electives	[None]
University of Tampa (Bachelor of Science in MIS)	1. Application Development 2. IT Infrastructure 3. Systems Analysis, Design, and Project Management 4. Data and Information Management 5. Enterprise Architecture and Systems Design 6. Global Information Systems Management + 1 major elective	[None]