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Interdisciplinary IT: A Expanded Approach

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Abstract

It is no longer possible for the CIS faculty to adjust to all new areas of their curriculum without help from faculty outside the discipline. This paper outlines a model for introducing interdisciplinary topics into Computer Information Systems (CIS) courses. The focus is on adding Data Visualization to the CIS curriculum, but also on leveraging faculty expertise from other disciplines, university resources and facilities to maximize development of potential courses, professional development seminars and workshops, and summer high school programs.

Keywords: interdisciplinary IT, data visualization, professional development workshops, high school summer program

1. INTRODUCTION

The field of IT is constantly changing and the task of maintaining state of the art programs and expertise within one department is challenging. Staying on the cutting edge is especially daunting in times of budget concerns as many public universities continue to see their state appropriations diminish and the ability to raise tuition limited. In addition, the cutting edge means that we acknowledge and address the way in which "The information Age has fundamentally changed the way we think and communicate…the influx of information needs to be consumed and processed, which requires new methods of communication" (Lankow, Ritchie, & Crooks, 2012, p. 12). For university faculty members, the effort to keep pace with new technology has created a significant rise in stress (Rhodes & Goveia, 2002). As more and more disciplines embrace and embed IT into their respective programs, emerging fields must find relevant expertise outside the IT department and any new developments must include leveraging the needed investment to satisfy multiple needs. The choice is not between adopting and not adopting a new technology, but a choice between adopting now or deferring the decision until later (Hall & Khan, 2002). This paper outlines a new vertical model for adopting a new IT area into the university curriculum and discusses the benefits of this model It explores the area of Data Visualization with a model that leverages areas beyond the

development of a credit course for students into other potential uses, i.e. the design of external professional development workshops and seminars, and summer sessions for high school students to be used as a recruiting tool for future students. A diagram of the expanded model is included in Appendix A. This model explored in this case study requires interdisciplinary expertise from multiple departments to staff a collaborative venture to understand, interpret, and visually present volumes of data in easily understandable ways.

2. BACKGROUND

Every career field has become more and more inundated with data. For example, marketing professionals track every purchase a customer makes, capturing and storing as much information about those customers as they can. Health professionals track patient data with electronic patient records. Social media professionals use tracking systems to collect and share data. Everything we do in daily life generates data that is tracked, analyzed, prioritized, and categorized (Fenske, 2010). How the data is presented, and how it tells the story visually can assist in decision making about current trends, inspire new ideas, and predict future behavior. As Computer Information Systems (CIS) degree programs adapt to new technologies, the pressures are on these programs to work with the current curriculum guide, IS 2010, for the essential technology expertise, but also allow flexibility to revise the curriculum to keep up with emerging trends. CIS programs need a model to build Big Data understanding into their curricula. Big Data has two parts: the first part can be integrated with the existing database curriculum; the second part involves graphic visualization to tell stories, isolate relevant data and improve decision-making.

As a group of professors and administrators discussed how to bring Data Visualization to the university, it became obvious that a great number of skill sets are needed by the team. Creation of visually literate workers demands cooperation among various college departments which may be separated by large cultural and institutional gaps. (Zyda, Cox, Katz, Larson-Mogul, Louie, Lypaczewski, Pausch, Singer, & Weisman, 1997) The university had a recent history of developing interdisciplinary pedagogical collaboration to benefit students. But Data Visualization required more partners in more disciplines than previous collaborations. Computer Information Systems faculty understood the need for data mining as databases continue to grow exponentially, making it harder and harder to glean relevant information from that data. Business faculty understood how presenting summaries of overwhelming amounts of facts and figures in a visual presentation could assist with discovering trends from a myriad of information. The Art faculty was intrigued with the compilation and presentation of vast amounts of data into an easily understood visual. One Art faculty member understood that human perception is important to make information patterns and trends visible and understandable, and that, as a graphic artist, one could tell stories with images. An Ethics faculty member understood the need to appreciate that all these data sets represent real people and that Data Visualization necessitates careful ethical thinking about our ethical responsibilities with the data. One Math faculty member understood the importance of the statistical goal of summarizing data with a certain degree of confidence would be crucial for the task of effective Data Visualization. This Statistician understands statistical methods and properties, and believes that graphical techniques have a place in data analysis. In pairing statistics and art, one can discover the unexpected through pictures (Yau, 2011). Each of the separate department faculty has expertise in one or more applicable areas although none has expertise in all areas. The team teaching approach reduced the learning curve for CIS faculty, and allowed faculty to focus on the topics most closely related to their area of expertise (Harris, Cummings, Dreher, & Chandra, 2004)

Data Visualization is also an ideal medium for both contesting disciplinary boundaries and deterritorializing skills because the subject matter requires a variety of forms of expertise. Information visuals (infographics) cause what could be meaningful to stand out in contrast to what's not worth attention (Few, 2009), and "The best visualization evokes a moment of bliss when seeing something for the first time, knowing that what you see had been right there in front of you, just slightly hidden" (Yau, 2013, p. xi). Traditional software can store data for future retrieval, but is limited in ways to support data analysis and interpretation. Data and statistics have become critical tools for organizations to plan and prepare for the future. But many organizations are drowning in data

spreadsheets; it is common for organizations to collect much more data than people can fruitfully analyze. The art professor was asked to take the lead in designing a course and a workshop to teach the presentation of volumes of data in graphic art form, an unusual decision by CIS faculty to outsource IT instruction to a non-technical field.

3. ECONOMIC NEED

The term Big Data describes the phenomenon of that which at first appears to be ever increasing data sets that are too large and complex to be able to process and easily find patterns and stories within them. As a result of Big Data, data analysts and institutional researchers have taken on a much more significant role in the running of organizations and businesses. The McKinsey Global Institute claims that an employment gap exists in the field of data analysis. "By 2018, in the United States, we estimate that 4 million positions will require (deep analytical) skills in a big data world." (McKinsey Global Institute, May 2011, p. 105). Google's chief economist, Hal Varian writes, "I keep saying that the sexy job in the next 10 years will be statisticians. The ability to take data—to be able to understand it, to process it, to extract value from it, to visualize it, to communicate it—is going to be a hugely important skill in the next decades" (Lohr, 2009, p. 1). One of the challenges, according to Terence Parr, is "to be successful, students need to have a wide range of skills that doesn't fit in one academic department" (Miller, 2013, p. 1). Ultimately, data findings will need to be communicated visually and orally, and successful data analysts will also need business know-how to develop new products, services and ideas (Miller, 2013).

Data visualization is the use of "computer-supported, interactive, visual representations of abstract data to amplify cognition." (Card, Mackinlay & Schneiderman, 1999, p. 7). Data visualization is considered a transversal discipline which harnesses the immense power of visual communication in order to explain, in an understandable manner, the relationships of meaning, cause and dependency which can be found among great abstracts masses or information generated by scientific and social processes (http://datavisualization.ch/about). Colleges and universities can be at the forefront of preparing computer and business professionals to turn all this data into useable and understandable information by offering not only stand-alone data visualization courses, but also in designing and offering workshops/seminars for professionals to understand how to incorporate visualization into their decision making process. Big Data analysis can no longer be limited to the discipline of computer science. It has spread to other disciplines with many practical applications. And the classroom is but one piece of the learning environment. Because of the interdisciplinary nature of the coursework, graduates who understand how to visualize data and how to present it to business people will be in high demand for years to come. The demand for them will far outpace the supply (Lohr, 2013; Thomson, 2012).

4. THE MODEL

In response to the need for data analysts, which we see as a valid outcome for graduates following the IS 2010 curriculum, the University has set a goal to develop a center for data visualization on its campus by the fall of 2013 using the expertise of all stakeholders. The model that we propose is multi-pronged, but the parts of the model can be introduced into the university concurrently. The introduction requires support from faculty and administrators to equip a lab to serve students in courses, and to use the lab for a variety of purposes. The lab will help to educate students in data visualization, serve external stakeholders through professional development workshops and offer a K-12 summer outreach program. Our model consists of 4 parts: 1) defining the economic needs, 2) conducting an external/local needs assessment, 3) determining the skill sets needed on the team, and 4) preparing appropriate facilities to house faculty and staff to provide courses, conferences, workshops, and summer programs.

Data visualization has the potential to provide organizations, data analysts and educators with the ability to see data in a variety of presentations with multiple relationships. In other words, visualization enables the use of visual structure to find patterns in complex data. Data visualization is an inherently interdisciplinary activity. It requires an appreciation of the aesthetic potential of graphs and charts. Identifying patterns and telling compelling stories with data require statisticians and computer scientists to possess skill sets to validate the data, including creativity, simplicity,

transparency, and relevance. And, it involves an understanding of how organizations might use data to plan and change. This involves an understanding of business management and methods. This interdisciplinary data visualization center will train the organizations' existing workforces to understand methods of interpreting vast amounts of information more easily.

5. THE NEEDS ASSESSMENT

To introduce the model into the curriculum required a needs assessment of the various stakeholders and using those results to adopt the model. In its assessment as to whether there was community support for more than classroom education, the university collaborated with three outside agencies: the local Chamber of Commerce, the State Arts Commission, and the State Mathematics and Science Alliance. The first represents over 650 organizations that promote economic development in the county region. Its reach extends in a 30 mile radius. The chamber also has a strong working relationship with local Chamber of Commerce in a nearby city which houses another institution of higher learning. The university already has a strong record of outreach to local businesses and non-profits for service learning, internships and other collaborative educational opportunities. The State Arts Commission's mission is based in expanding and providing access to the cultural heritage and programs of the state. The Commission has been a champion of the creative economy, promoting the benefits of a strong arts and culture community for the economy of the state. As art and culture becomes more technologically focused, the State Arts Commission is focused on the important cultural work involved in technologically produced culture. The Arts Commission is helping the university identify non-profit organizations that would benefit from data visualization with their organization's data. Finally, the State Math and Science Alliance supports Science, Technology,
Engineering, and Mathematics (STEM) initiatives for local K-12 students, and the university is committed to collaborating with local high school teachers and students to educate them about careers in data analysis and data visualization. This built on our previous collaboration with the Math and Science Alliance to offer a youth summer college program for high school students in architecture, one of the STEM disciplines, in 2013. The university will conduct a survey of local high schools to determine what kinds of opportunities for high school students in data analysis and visualization we can provide. The center for data visualization will also be a regular part of college tours at the university. Starting in the spring semester of 2014, we will explore a variety of ways to expose high school students to the possibilities of this technology.

6. THE TEAM

The investigative team for this data visualization initiative includes an expert on visual thinking and design; an expert on computer statistics and GIS applications; an expert on ethics and general education outcomes; an expert in statistics; and an expert in areas in management and business administration. This team has been meeting for the past few months reviewing the literature on data visualization and planning for the development of a data visualization center at the university.

The team's work is ongoing. In spring semester 2013 the University began construction of the data visualization laboratory. The university contributed a classroom to be refurbished as the data visualization laboratory, completed during the summer of 2013. During the spring, faculty also prepared instructional material for offering a data visualization course in the fall semester. Finally, in collaboration with the local Chamber of Commerce, the State Math and Science Alliance, and a consortium of K-12 educators, the University designed and implemented a survey to identify data visualization needs of local businesses in order to tailor training to their data visualization needs.

7. MILESTONES

The contribution of new technology to economic growth can only be realized when and if the new technology is widely diffused and used (Hall & Kahn, 2002). The university has determined five milestones for progress on this model incorporating a data visualization project. The university has acquired institutional knowledge about data visualization. Currently, faculty and administrators across the university have knowledge of the impacts of visualization and data analysis. From the summer of 2012 until the present, the art professor and the CIS professor have been working on developing their knowledge of data visualization by presenting internal university data in visual form, including data on program coordinator release time.

The second milestone for this project is the physical creation of the data visualization laboratory in the library on the university's campus. This occurred in June 2013 and involved eight screens, with software and hardware to manipulate data. It will also enable the University to develop workshop sessions with nonprofit organizations for the summer of 2013.

The third milestone is the development and teaching of a 3-credit CIS course, Data Visualization, in the fall of 2013. As part of the course, students will work with data from organizations in the central part of the state for planning and decision making.

The fourth milestone for this project will be the development and presentation of professional development workshops for businesses and organizations. This will occur in the spring and summer of 2014, and will continue to accommodate the needs of local businesses and organizations.

For the final milestone, the university has begun the process to develop a data visualization center for use within the university and by groups external to the university. Faculty who have expertise in the appropriate fields are committed to make this project a reality. The University has committed funding for release time, travel, development, and the classroom space. The university has begun purchasing the software for data visualization projects. In addition, interest has been cultivated from community organizations like the local Chamber of Commerce, the State Mathematics and Science Alliance and the State Arts Commission. All three groups are interested in the possibilities of educational and workshop development using the data visualization laboratory.

8. PROFESSIONAL DEVELOPMENT

The economic benefits to the community primarily involve workforce development, with workshops for local businesses serving as an opportunity for these businesses to plan and take advantage of opportunities based on the data that they collect. If the university can satisfy the employment need for data analysts, this will enable businesses and organizations to preserve their operations in the state and not have to travel outside the state to satisfy their data analysis needs. The primary objective for the laboratory is the development for workshops for local businesses. The workshops will enable businesses to plan for the future and develop new opportunities and products based upon the manipulations and visualization of data in order to detect patterns and capitalize on those patterns. This linkage with local business organizations will enhance the University's partnerships with the Chamber of Commerce, and enhance our ability to offer professional development training for local businesses. The development of these workshops will be guided by the businesses' response to this survey.

Over the summer, the team will continue to explore the visualization of data sets, mostly produced internal to the University. This will further develop the University's institutional knowledge regarding the potential for data visualization and best practices in the field. The team will also conduct trial workshops with local non-profit organizations, to work with the data that these institutions have developed. In the fall of 2013, the university will run the data visualization course as in IT elective. This course will identify and develop the potential undergraduate research assistants for the data visualization lab. This course will also work with data from local non-profit organizations that have data visualization needs.

At the conclusion of 2013, the university will have the laboratory and the faculty and student undergraduate research expertise to offer our center for data visualization to external businesses and organizations. Starting in the spring semester of 2014, the university will offer two-day workshops using faculty and undergraduate research assistants, based on results from the business survey. These workshops would either explore participants' own data, or educate participants in the value of data visualization using non-proprietary data. The workshops will enable the university to partner with the local business community to use the techniques of data visualization in professional development for the local workforce. In addition, the university will use the data visualization lab as a resource for different degree programs, including the possibility of developing certificates or programs in the area of data visualization itself. Third, the center will be available to local artists and arts organizations during the summer, through our partnership with the State Arts Commission, both for exploring the artistic potential for data visualization and the potential for arts organizations to explore their own data in an

effort to increase the local creative economy. Finally, the university will survey local K-12 educational institutions in early 2014 to determine how best to conduct outreach to students and faculty in these institutions.

9. FACILITIES

The facilities that are developed will be constructed as multi-use: for courses, research, workshops, and summer programs. The Center for data visualization will be located in the library and will not be owned by any program. It will enable the University to more fruitfully analyze the program and student data that its own institutional research office produces. It has potential to support the university's general education requirements in critical thinking and information literacy. It will support the University's Computer Information Systems program. It will be a resource for public K-12 teachers and students to discover the world of data analysis and visualization. Finally, and most importantly, it will be a resource for workshops and professional development for businesses and community organizations who are working with their own data. Data at the right time and in the right forms enable stakeholders to recognize patterns, guide decisions and communicate information to others objectively and clearly.

The university's Center for Data Visualization will best use limited resources to leverage the data of each individual business or organization. The Center's laboratory will enable users to project different visualization techniques to present their data and evaluate these various techniques for clarity, accuracy and overall narrative. Collaborating businesses and institutions across the region will have better techniques for manipulating and telling a story with their own data. The equipment that will be provided includes eight large screens to manipulate data images and present different methods of visualization of the data in a wall of screens that will enable workshop participants to review different methods and ways of visualizing their data in real time using workstations, graphics processors and switcher kits to be able to effectively manipulate this information on the screens. This equipment is critical for the development of the laboratory in order to have individuals collaborate with each other in a public space for the development of appropriate data visualization techniques. With a server license for a software package, individuals, groups, businesses and institutions will be able to manipulate and use the appropriate software on their own, but it is in the laboratory setting where the educational transactions that help develop the knowledge of data visualization takes place. The multi-screen data visualization lab enables participants to test out various ways to demonstrate the narratives that can be found in the data, and produce graphics for internal and external consumption.

Further this data visualization lab "enhance[s] the entrepreneurial infrastructure to foster greater growth and market opportunities for start-ups and small technology businesses" (http://www.maine.gov/decd/innovation/pdfs/2010_S&T_Plan.pdf, p. 10). The entrepreneurial infrastructure enables small and mid-sized organizations from across the range of industries and technologies to visualize from where opportunities and threats arise and how to meet them. In particular, the data visualization lab would satisfy the targeted sector in the implementation plan, information technology.

Both the workforce development and the workshops for local institutions will preserve existing jobs in the state because organizations will have access to data analysis and visualization locally. As a reference claims in her letter of support for this project a, lack of educated STEM workers means that many technology businesses in southern and mid-state areas are considering setting up shop elsewhere. This would be a tremendous loss to the state's economy. The university can play a critical role in changing this situation by involving more students in data visualization. This data visualization center will provide a new service for people and institutions. It will enhance the university's linkage with the local business community and provide professional development for their workforce.

10. CONCLUSION

The economic success of this project will be measured in the number of businesses that take advantage of this workforce development opportunity. Success will also be measured by the number of students that are trained to become data analysts and data visualization technicians; the number of K-12 schools and students who are exposed to this technology and the capabilities of this technology; the number of artists using the laboratory to work on the intersection of art and data analytics; and the

number of non-profit arts organizations that take advantage of the data visualization workshops to increase the strength of the creative economy in the central section of our state.

It is no longer possible for the CIS faculty to adjust to all new areas of their curriculum without help from faculty outside the discipline. Visual literacy is one of the most critical skills that span both art and science (West, 1991). The CIS faculty needs greater flexibility to draw on the expertise of faculty in other fields to incorporate CIS/IT into every college discipline. This, we believe, is a good model for future advances by leveraging resources, faculty, and facilities to provide opportunities for knowledge across the curriculum.

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APPENDIX A

A diagram of the model discussed in this case study is shown below: