Managing the Innovation Process: Infusing Data Analytics into the Undergraduate Business Curriculum (Lessons Learned and Next Steps)

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ABSTRACT

The designing of a new, potentially disruptive, curricular program, is not without challenges; however, it can be rewarding for students, faculty, and employers and serve as a template for other academics to follow. To be effective, the new data analytics program should be driven by business input and academic leadership that incorporates innovation theory and practice concepts. Similar to many innovative projects, our journey began with a business problem, i.e., the explosion of data from a plethora of sources, the realization that data transformed into information and intelligence can generate business value, and the recognition that there are currently too few graduates with the necessary skillset to make this happen in the foreseeable future. The approach developed here may provide other universities with a path toward an information systems curriculum that is more in tune with the emerging big data world.

Keywords: Data analytics, Innovation process, Curriculum design and development, Business relevance

1. INTRODUCTION

In this article, the author asserts that the Internet of things, the increased categorization and quantification of business records, and the explosion of social media and user generated content has provided a treasure trove of data that can be transformed into information and ultimately into business insight by the application of analytics (Goh and Sun, 2015), i.e., "the scientific process of transforming data into insight for making better decisions" (Informs, 2016). In this emerging big data/analytics era, businesses are increasingly looking to the information systems discipline to holistically combine data, programs, experiments, and algorithms to aid in decision-making and ultimately to gain competitive advantage (Wilder and Osgur, 2015). The two key players in this arena are businesses that will lead the transformation and academic institutions that will supply much of the talent necessary for the transformation (Wixom et al., 2014). As of today, in the information systems academic arena, there has been considerable experimentation in creating courses to provide the requisite students skills, but few integrated curriculums, and no dominant design (Topi, 2016). One way to gain insight on how best to fill these gaps is to compare a "dream" Business Analytic curriculum put forth by an IS scholar against an actual curriculum model developed at our university (Wang, 2015). Similar to Koch and Kayworth (2009), the author has developed a form of case-based research where the researcher is directly involved in the phenomenon being studied (Baskerville and Wood-Harper, 1996).

The author began the curriculum design effort at his university with a situational analysis of what is changing in the emerging data-centric business environment and how this is affecting business demand for analytic talent. This sets the stage for a curriculum audit of existing IS programs and challenges they are facing. The author then presents a proven model of curriculum change that was used, followed by the components of the new Data Analytics major. Next, the author presents the innovation process model that guided the design of the new major and concludes with how the program compares with an ideal curriculum and what has been learned.

2. DATA CENTRIC BUSINESS ENVIRONMENT

The amount of data in the world has been exploding, and analyzing large data sets – so-called big data – is becoming a critical basis of competition, underpinning new waves of productivity growth, innovation, and consumer surplus (Manyika et al., 2011). Organizations around the world are struggling to develop the know-how to aggregate, analyze, and most importantly, monetize the growing surge of available data (Heinz, 2016). The domain of big data has been categorized into two broad but related areas: Data

Engineering is the finding, organizing, cleaning, sorting and moving of data; and Data Science is about improving decision making from the ever increasing quantity of data and ultimately generating knowledge and insights by extracting value from data. Because the former, data engineering, is performed at the tactical and operational level, and the latter is done more at the analytical and strategic level, this makes designing a comprehensive data analytics major including both difficult.

A study of the McKinsey Global Institute estimates that by 2018 there will be 4-5 million jobs in the U.S. requiring data analysis skills – and large numbers of positions will only be filled through training or retraining (Data Society, 2016). This new generation of scientists and engineers must possess a broad range of distinctive skills not present in any one academic department. Therefore, the creation of a comprehensive data analytics curriculum must draw upon at least two central areas: computer science (databases and programming) and analytics (math and forecasting). However, data analytic knowledge is quite useful in a variety of discipline areas in the business school, for instance, forensic accounting, digital marketing, application development, financial engineering, and healthcare administration.

3. INDUSTRY DEMAND FOR ANALYTICS AND THE SKILLS REQUIRED

Educational entrepreneurs often look to their environment to obtain clues and signals for future programs (PWC, 2015). In 2014, our university was working on a "Big Data" project with the Business-Higher Education Forum (BHEF), the nation's oldest organization of senior business and higher education executives dedicated to advancing solutions to U.S. education and workforce challenges (BHEF, 2016). A year earlier, Burning Glass Technologies (BGT) prepared for the BHEF a report entitled: *Report on New York Financial Services Industry Jobs: Data Analytics, Risk Management, Cyber Security, and Social and Mobile Technologies*. The below Burning Glass survey results identified business needs as well as the skill sets required of graduates in the New York City area. In 2013, there were 532,337 postings for Data Analytics in the United States, with 297,430 Business-Finance Analysts (analysts in occupations that typically require a business or finance degree and substantial mathematical skills), 193,661 Core Data Analysts (math or quantitative degrees), and 41,246 Data Scientists (advanced degrees). In 2013, there were 57,122 postings for Data Analytics in the New York MSA. Data Analytics demand in the New York MSA is highest in the Financial Services Sector with 23,085 or 40% of the Data Analytics postings. Nationally, 25% of Data Analytics postings were in the Finance sector.

In 2015, BGT prepared a follow-on report for the BHEF that identified skill sets for Data Analytics jobs. They included balanced knowledge of statistical package skills (SPSS, SAS, R), Microsoft Office (PowerPoint and Excel), more specialized financial skills (financial planning, risk management, and underwriting), some programming, critical thinking skills, and an ability to communicate results (BGT, 2013, 2015). These findings are consistent with the BIC3 survey in 2012 that found 89% of employers agreeing that their need for Business Intelligence/Business Analytic (BI/BA) skilled recruits will increase in the future (Wixom et al., 2014). Representative BI/BA careers and associated salaries are listed in Appendix A (ASU, 2016). In response to this industry demand, Hill and Kline (2014) concluded that education professionals must be able to help students obtain the experience and expertise that they need to fill data analytic positions.

4. BUSINESS/DATA ANALYTICS CURRICULUM AUDIT – 2016

Business Analytics education has begun to attract IS scholars' attention including two panel discussions held in the leading IS conferences in 2014 (Schiller et al., 2014; Agarwal et al., 2014). The "datascience.community/colleges" website in May 2016 stated that there were 517 data science/data analytics programs of which 374 were Master's programs, 88 Certificate programs (mostly at the Master's level), 36 Bachelor's programs, and 19 PhD programs (Colleges, 2016). In Appendix B, more detail is provided for the Bachelor's programs, the focus of this paper.

While most of the programs were offered by business departments (31%), computer science departments accounted for 21%, followed by math and statistics at 14%, and only 7% were offered by interdisciplinary departments; however, Wixom et al. (2014) observed that the interdisciplinary track is becoming more common. If the department offering the major was business, then the program was most likely called data analytics, while if the department offering was computer science or math/statistics, then the program was called data science; however, complicating any comparison among programs were additional names given to the majors, for instance, Information Systems Analytics, Computational Data Science, Applied Data Analytics and Visualization, Risk Management, and Business Intelligence. Approximately 90% of the data analytic/science programs were offered in English speaking countries and, not surprisingly, most of the smaller schools and the Polytechnic universities did not offer follow-on Master's programs. A May 2016 query of the AACSB database including almost 1,500 institutions indicates the similar paucity of undergraduate (UG) analytics programs, i.e., the database listed only 11 UG "data analytics" and 3 "data science" programs, but 56 program were included in the broader category of "business analytics" (AACSB, 2016). However, Klimberg and McCullough (2013) warn that many academic institutions simply attempt to rebrand themselves by changing the name of their courses and programs to include analytics and are really not comprehensive, integrated programs (Gorman and Klimberg, 2014).

Wang (2015) and Wilder and Ozgur (2015) both highlight that most business analytics programs are in the College of Business, are in their infancy, lack a commonly accepted curriculum model, and are void of an appropriate pedagogical design for developing student professional skills. Goh and Sun (2015) state there are not many IS publications on research regarding business analytics teaching and learning. Wixom et al. (2014) further state that there is a dearth of existing guidelines and model curricula in the business analytics area and this has hindered the development of new programs. They concluded that the following fundamental questions remain unanswered and need to be explored: "How many courses should be offered in a BI/BA major or BA minor? Should BA programs be integrated with other majors inside and outside of IS? What is the best way to begin and then to evolve BI/BA programs at our university?" In an attempt to provide some guidance, Wang (2015) provides a wish list of implementation guidelines for a "dream" business analytic program:

- Develop new interdisciplinary courses by collaborating with other departments or industries
- Align BA course offerings with the needs of practice
- Consider using real-world projects that allow students to work with industry professionals and learn how to define the problems and collect, organize, analyze, and visualize data
- Capture the union of statistics, quantitative methods in the field of operation research, and management information systems in an ingenious BA curriculum
- Strengthen the faculty members' expertise on business analytics and intelligence.

The author believes these can serve as a reasonable benchmark to evaluate emerging programs.

5. CURRICULUM MODEL

A literature review indicated that there is no shortage of models that could be used for curriculum redesign (Borin and Metcalf, 2010; Koohang et al., 2010). The author chose to use the Association of Computing Machinery/ Institute of Electrical and Electronic Engineers – Information Technology (ACM/IEEE – IT) undergraduate curriculum model as our guide because of its proven track record and because of the similarities to the field of information systems and analytics (ACM/IEEE – IT, 2008; Wymbs, 2011).

This model is simple in design and consists of two phases. Phase I involves the design of the framework that encompasses formulating the program mission and program accreditation, establishing career goals, and establishing program competencies. Phase II focuses on the design of specific courses in the curriculum and includes the design of foundation and advanced courses (Koohang et al., 2010).

5.1 Phase I

The mission of the Computer Information System Department at the author's university is to educate students with a strong foundation in the business and managerial issues related to information technologies and to understand how emerging technologies can be used to facilitate strategic advantage in the marketplace. The Data Analytics major depicted in Appendix C is consistent with the Department's mission of applying new technologies to achieve strategic advantage and became a standalone "accredited" program after it was approved by the school and college curriculum committees, thus fulfilling the accreditation phase.

In many ways, industry responses to the evolving big data, analytic-enabled environment can be used as a curriculum guide. As indicated in Appendix A, new career areas and new categories of jobs in business analytics indicate where firms have already made resource commitments. If academics want to remain relevant to business, it behooves us to create courses and new curriculum that provide our students with basic levels of knowledge to address many of these critical areas of business (Mills et al., 2012). As will be detailed in a later section, our courses and program relevance were greatly enhanced by having leading-edge businesses be co-designers of our curriculum.

The last area associated with Phase I is establishing program goals and competencies, that is, the knowledge and skills students should have by the time they complete the program. Our goal for the Data Analytics major is to provide students with a relevant educational experience consistent with the emerging big data environment that promotes competence in the emerging field of data analytics and the capacity for career success. As indicated previously, the basic need driving the above goal revolves around the emergence of data in most all aspects of our lives and the need to transform data into information and ultimately into business intelligence.

Because our school is introducing a new discipline, a learning sequence could be developed that moved the students along Bloom's cognitive goals hierarchy (Bloom, 1956) that begins with introductory courses that serve to establish a fundamental competency in the basic knowledge areas of programming, database structure, and data mining. These are followed by elective courses where students, via projects, apply and couple these core concepts with advanced analytic tools to better understand how data is identified, prepared for analysis, and used in context. After completing the program, students are expected to have the competencies associated with the learning goals in Appendix D.

5.2 Phase II

Much of the Phase II rationale (design of specific courses in the curriculum) is explained in the "Innovation Process Model" section that immediately follows; however, the guiding principles of this phase are driven by collective design based on discussions among industry players, BHEF members, and our academic staff. The author found it extremely effective that after each BHEF data analytics/big data forum, there was a post mortem session identifying what items were advanced, what were open issues that required our attention, where industry could help, and what should be done for the next forum. In many ways, these closing-the-loop sessions were like a modified Delphi approach recommended by Wang (2015). Specifically, the BHEF members stimulated discussion between the academic and the business community on what is required to provide students with the requisite skills for future employment in the business analytics area.

6. INNOVATIVE PROCESS MODEL

There is no reason why innovation in course design and program development should be different than any other business innovation process because innovation represents a core renewal process of any organization, refreshing what it offers and how it creates and provides that offering. The basic, underlying innovation process centers around four key activities: Searching – scanning the internal and external environment for signals, threats, and opportunities; Selecting – deciding upon which of those signal to act, being guided by strategic intent; Implementing – translating the initial idea into a specific service and launching that service into the marketplace; Capturing Value – including both learning from the experience and sustaining adoption of future innovation (Tidd and Bessant, 2013). Our school followed a similar process model in creating the data analytics program and the key steps are highlighted below. Of course every school has a unique path-dependent process and if it chooses to pursue a similar major, the steps will not be identical to the ones described below; however, there should be many similarities. (With the passage of time, some of the preliminary search steps may be skipped.)

6.1 Searching

As indicated above, the press and leading journals began writing extensively in the 2011-2013 timeframe about the merits of big data and the need for data scientists. As an academic institution, an assessment was required. Was this just over zealous promotion like the dot-com bubble, an incremental innovation that just involved the creation of a few new courses, or a disruptive innovation resulting in the start of a new trajectory, a paradigm change (Christensen, 1999). In early 2014, the new Executive Director of Undergraduate Programs began to research what other schools were doing in this area (some graduate courses and a few graduate programs had been created, but no undergraduate ones were found). The area appeared to be evolving quickly and unless courses and a program could be developed relatively rapidly, a new curricular proposal ran the risk of always being in a catch-up mode to where the industry was (Surendra and Denton, 2009).

Simultaneously, the Executive Director began testing the waters with industry players to see if they would be interested in hiring undergraduates with data analytic skills (Conference, 2014). This was accomplished by simply asking senior-level presenters from companies like Google, Facebook, IBM, G.E., SAS, and Digitas, at several digital marketing conferences in New York City, about industry trends and their need for talent in this area (Wymbs, 2011). Exploration of these lead-user demands was a key source of information in identifying early signals of emerging trends (Hienerth, Lettl, and Keinz, 2014). Also, the Executive Director tested the concept's reception from companies, via a formal presentation, at a digital and direct marketing annual meeting (Wymbs, 2014).

A white paper was developed highlighting the findings of the above exploratory efforts and presented as a preliminary framework of what could be accomplished at our school in this area. Initially, this was shared for comments with people in the functional areas who had shown an interest in the data analytics area and then with the Dean.

6.2 Selecting

Obtaining the Dean's approval to proceed was a necessary first step in the selection process. However, the creation of a new, interdisciplinary program that involves different functional departments creating courses is potentially fraught with many internal political problems, such as where should the major reside, could it be a networked major, how to avoid duplication of courses, how to facilitate integration of courses, what courses need to be created first, which department should create them, how will they be shared across department majors, and what are the prerequisites.

The head of the curriculum committee and representatives from each of the involved departments were invited by the Executive Director to be founding members of the data analytics initiative. The white paper served as an informal direction guide, but discussions were robust and encompassing. To mitigate the political issues, the initial proposal had a set of data analytics core courses (data mining, programming, data management, forecasting) and each department would specify and create discipline specific courses to create their own major. All departments were invited to join, but only three became active members (Marketing, Management, and Computer Information Systems (CIS)).

The committee findings were presented to an expanded group of faculty from all of the involved departments. A major concern raised was that there would be a governance issue because no single department would be able to manage the whole curriculum. The committee and Executive Director originally defended the original proposal and thought of ways that it could work, but the extended discussion group appeared to have a valid critique and the Executive Director was required to rethink the approach. Simultaneously, the committee realized that the implementation time for its initial approach would take two and a half years to navigate through the bureaucratic challenges of a new major in a large university system. (The Executive Director had gone through a similar process for the school's new International Business major a few years previous.)

Because the departments, the Executive Director, and the curriculum committee chair had been working together from the beginning of the project, they had a brainstorming session to attempt to develop a solution that could come to the market relatively quickly and still involve considerable inter-department cooperation. The Marketing Department several years earlier created a Digital Marketing track within its major and this only required school approval (a one-year process). A track is viewed by employers as a major, but did not require the same level of university approvals because it was done within a department.

The Executive Director and committee decided to create a marketing analytics track in the Marketing Department and a data analytics track in the CIS Department. These tracks would share core data analytics courses, and each department would design the track's elective courses to meet its unique needs. (See Appendix C for a list of courses in the two tracks.)

6.3 Implementing

Simultaneously, with the creation of our analytics programs, the Business Higher Education Forum (BHEF) embarked on a public/private partnership with us to increase high demand skills (business analytics) for the business community and the finance industry in particular. The College is a public institution, part of a larger University, and graduates the most Accounting and Finance majors in the U.S., so it made sense for the BHEF to seek a partnership from many perspectives. With the BHEF partnership came access to Burning Glass Technologies' research on skills required for 21st century workers. As discussed previously, many of the skills identified were consistent with the learning goals of the planned new courses.

After an initial meeting in October 2014, the College partnered with the BHEF and agreed to host an industry finance conference in March 2015. Course development within the Marketing and CIS departments continued. Some of the undergraduate courses were modeled after MBA courses, such as Data Mining, while others were developed based on the interest of faculty, e.g., Text Mining. Other courses already on the books, such as Data Warehousing, were updated to meet the requirements of the proposed new major and skills identified in the Burning Glass research.

The March 2015 BHEF Conference that included investment banks, accounting firms, book publishers, tech companies, the Federal Reserve, and banks confirmed that the College was on the right track but also highlighted areas in need of development. On the confirmation side, industry participants indicated that the statistical package should be "R" and the programming language should be Python. On the development side, the industry view was that academics were not moving fast enough in the finance and accounting areas and that data science skills needed to become more pervasive for new graduates. They also indicated that they would like to become involved in assisting to implement this approach. The accounting community went so far as to say that they would think about making data analytics proficiency a requirement of hiring new accounting employees. Based on this input, our school decided to add a business minor in data analytics to our proposed offerings. The business community indicated that they would contribute datasets for data mining, internships for our students, the writing of case studies to use in classes, and the offering of advice on the program throughout its development.

In the spring semester of 2015, the analytics courses, the tracks in CIS and Marketing, and the minor in data analytics were brought to, and approved by, our curriculum committee and our faculty, and they were sent to the Chancellor for final approval. Students can graduate with these majors and minors in one year; however, they can begin taking courses immediately.

6.4 Capturing Value

Much has been learned through the two-year curriculum development process and this serves to build the knowledge base to further investigate data analytics initiatives at our school. Even though a large part of curriculum development is a linear process, there are also dynamic elements. Our initial task was focused on the creation of courses and the associated major programs within our school; however, the BHEF encouraged us take a more holistic approach.

The BHEF raised several questions that stimulated our thinking of what was possible and how the school could build upon the majors/tracks and repurpose the knowledge accumulated during the creation process. The BHEF questions are followed by our responses:

- Would students benefit if they obtained exposure to data analytics earlier in their education journey, rather than just when they entered our business school in their junior year? **Response:** The answer is a resounding yes. The school is in the process of creating a General Education Course on data analytics that will not have any prerequisites and will be similar to the one offered by Temple University (Miller, 2016; Schuff, 2016). In addition, the school plans to share these syllabi with the community colleges in our system so that their students (and eventually our students) may benefit from our creative design work in the data analytics area.
- Were there other ways outside of the traditional curricular approach to stimulate data analytics understanding within the school? **Response:** Yes, we proposed the creation of a university-wide, structured, non-credit "Data Analytics Achievement Award" that is open to all students who have an interest in the area. This club-like activity brings students with an interest together and becomes part of the pre-sell for data analytics courses and future majors.
- Could data analytics related courses be leveraged to help create other related, in-demand majors such as Cybersecurity? **Response:** Yes, we created and obtained approval to offer a Cybersecurity and Information Risk Management Track that co-lists some of the Data Analytics courses.
- Could the school partner with industry to create special internship/work study data analytics programs for students from under-represented areas of our college? **Response:** Yes, industry players are in the process of identifying such internship opportunities and should report back at the next BHEF meeting on this topic.

The undergraduate courses in data analytics are being offered in the Fall 2016 semester, and we will know in a year or so the success of our major and minor offerings. The key success indicators of an academic program are students voting with their registrations (see Appendix C for preliminary Fall 2016 numbers) and employers hiring these students. However, in the interim, we will monitor student course evaluations to determine if we are achieving the course learning goals outlined in Appendix D.

7. TYPES OF INNOVATION

A key reason why the creation of a cross-disciplinary, innovative curricular activity is difficult is that it does not involve just one type of innovation but rather many different types (product, process, position, and paradigm) simultaneously. A brief description of each innovation type is provided and then its application is discussed in the context of creating the data analytics programs: Product innovation – changes in the product or services an organization offers; Process innovation – changes in the way they are delivered; Position innovation – changes in the context in which the product/service is delivered; Paradigm innovation – changes in the underlying mental models that frame the initial offering (Tidd and Bessant, 2013).

7.1 Product Innovation

At the most basic level, product innovation at a university focuses on the creation and offering of new courses. With regard to Data Analytics, the first of such courses offered was in the area of Data Mining at the MBA level. At the undergraduate level, interest was quickly growing in the quantitative data area in our newly created track in Digital Marketing. Further product innovation was the creation of new data analytics courses, such as Business Intelligence, Text Analytics, Introduction to Semantic Technologies, and Data Visualization, and the desire to package these courses into a formalized offering as a track. As indicated above, product innovation is often both path dependent (building on the key resources you have such as instruction talent) and a dynamic process.

7.2 Process Innovation

The creation of the data analytics undergraduate major required a change in the traditional silo mentality within a business school. Data analytics cuts across many different courses that historically were located in many different areas, such as forecasting, programming, database analysis, the Internet, big data, and marketing. If the traditional business school approach of department independence was maintained, there could have been many overlapping courses with each department vying to gain first mover advantage and stake a claim in the rapidly expanding big data space.

Here is where leadership is important. An administrator (Executive Director in this case), who has responsibility across departments, should put forth a vision and exercise coordination skills that demonstrate to department chairs that cooperation among the departments will lead to a better department and school outcome than competition among them. Having departments involved from the beginning and co-developing changes to future data analytics majors significantly helped the innovation process.

7.3 Position Innovation

Historically, new programs within a university have had a department focus. That was not the original approach that was planned for data analytics. Our initial plan was to create an interdepartmental major with the four core courses (Introduction to Programming, Data Base Administration, Data Mining, and Data Visualization) being taught by different departments and then have each department create elective courses to complete the department concentration. The major would be called Data Analytics with a specialization in Marketing, Data Mining, or Health Care Management. The control of the major would be by an interdepartmental group of the contributing departments. Here is where contextual factors and human dynamic factors (HDF) need to be considered.

From a HDF perspective, the departments knew best what was required to get their students jobs, felt best able to tailor a curriculum toward that end, and did not want to lose control of an emerging major in its early stages. From a contextual basis, the creation of a completely new major at our institution required school, college, city, and state approval and would take over two and a half years; however, the creation of a track within an existing major could be done within a year. As explained above, the need to get to market quickly coupled with the desire by the departments to influence their offering, and a willingness among the departments to cooperate with the sharing of courses and planning to avoid course duplication, led to separate department offerings sharing both core and elective courses.

7.4 Paradigm Innovation

Although paradigm change is relatively rare, when it happens it establishes a new trajectory for the businesses. If one starts with the premises that there is an explosion of data from a plethora of sources that is beginning to be transformed by businesses into competitive advantage and there are too few graduates with the necessary skill set to make this transformation happen, then there is a fundamental need to better integrate data analytics into the undergraduate business curriculum. The creation of new courses within the business area is clearly incremental innovation, while the creation of inter-departmental collaboration and the plan to infuse data analytics into the curriculum of our freshman students borders on radical innovation.

The BHEF encouraged us to introduce data analytics throughout our university to first year students who have not had calculus, statistics, or CIS. This would require a new mental model of curricular development because it would involve the Provost and the Dean's office from another school to implement. Specifically, it involved a two-course sequence. The first covers the data analytics thinking to frame business problems and included fundamental principles that guide the extraction of knowledge from data. The second is a laboratory course that solves several types of real world data analytical problems such as churn (predicting when customers will leave), classification, similarity matching, and clustering (Provost and Fawcett, 2013).

Rarely does the chancellor of a university ask to be briefed about a curricular activity, but that is what happened. In his presentation to industry and academics, he strongly supported the creation and introduction of data analytics in our first year curriculum. This provided us an added benefit to share background material on the data analytics project in a favorable light with our Provost and President.

Radical innovation often requires a significant redesign of previous processes. When the school includes data analytics in our core curriculum, future data analytics courses (referenced above as major courses) will have to be substantially revised to account for the increased knowledge of the entering students. Also, as a core curriculum course, it will serve as a great foundation for other majors in our colleges that are part of our university system, such as genomics, computational biology, forensic, computational geography, engineering, and psychology. School officials are in the process of meeting with our provost organization and community colleges to see how most efficiently to implement this approach.

8. CONCLUSION

As indicated earlier, Wang's "dream" criteria for the development of a new business analytics program could serve as a good benchmark for the evaluation of a fledgling program. The author now concludes by performing such a review.

1) **Develop new interdisciplinary courses**: The author and Wixom et al. (2014) think that it is essential to have a strong collaboration between departments to develop new data analytics courses and rapidly rollout a new program. This occurred for the new Data Analytics program. Three of the new electives were developed by the marketing department, the preliminary syllabi were reviewed by the information systems group, and four of the electives were offered by the statistics department. Coordination is also important in the introduction of analytic thinking in our pre-business core CIS, math, and statistics courses. The University of Arizona approached this problem by restructuring their statistics and calculus courses to be project-oriented and have students work in groups to present their work (Wilder and Ozgur 2015). However, the development of true interdisciplinary courses and then team-teaching them for an emerging area is risky, time consuming, and foreign to our department structure. To expedite the offering and to mitigate potential political issues, the departments chose to use an upfront coordination approach and cross-list courses between departments. We may revisit the interdisciplinary course design approach as the major evolves. However, our university's rigid institutional structure associated with teaching load requirements does not encourage team-teaching.
2) **Align BA course with needs of practice**: The author agrees with Mills et al. (2013) and Surendra and Denton (2009) that relevance is a key cornerstone of any new business analytics program. The simplest way to achieve course relevance is by getting business input in the design stage of the courses and curriculum. Initially this was done in the concept testing stage with informal industry contacts at conferences, and was formalized via the industry contacts the BHEF and the Business Roundtable brought to our effort (BHEF, 2016). The Business Intelligence Congress (BIC) performs a similar relevance check by using a survey to surface gaps between academic efforts and marketplace needs and to identify next generation workforce priorities (Wixom et al., 2014). Based on their needs, industry strongly encouraged us to use Python as our program language, R as our main statistical package, and to understand the importance of data mining, visualization, and text analytics courses (Conference, 2014). Our geographic location in the largest global center of commerce aids us in the creation of new leading edge programs and supplementing our teaching requirements with skilled adjuncts.
3) **Using real world projects**: The more problem solving data analytics templates students can learn and the more real world projects they can perform while in school, the better prepared they will be for the employers (Mills et al., 2012). Toward that end, the author and his colleagues have been working with industry professionals and have made this a priority for our interactions. Specifically, they have sought help from the business community in providing projects for capstone courses, helping to write and/or screen cases for class analysis, and providing data sets for analysis. The school is also working with companies to provide our students with internships for our various major and minor programs. Internships will provide us real-time feedback on how well the school is preparing our students and how we might have to evolve our programs in the area of additional courses and/or skills sets taught.
4) **Capture the union of disciplines**: The collaboration of the Marketing and Statistics Departments in offering the CIS-sponsored data analytics track has built strong inter-departmental relationships (Wymbs, 2014). Management Science was part of our initial planning team; however, their resources were initially focused in the graduate arena. The author hopes that they will engage in a minor redesign of their graduate health care analytics course and offer it in our program to increase the program's breadth. There is also the possibility that the Law Department may partner with the Marketing Department to offer a sports analytics course. One potential weakness for us is that the union of disciplines was based on personal relationships and the desire to accomplish something needed and new by the team. As leadership changes and the burdens of everyday academic life take over, the motivation of the program creators to teach and grow the programs could wane.
5) **Strengthen faculty members' expertise**: The creation of any new program requires a critical mass of faculty to initiate it. Fortunately, leaders in each of the key departments (Marketing, CIS, Management, and Statistics) have recognized the trend in this area and have chosen to build their own skills. When the idea of the new major was floated by the Executive Director, the department representatives wanted to be part of the inaugural team and took a leadership role in its development. Also, because the school is a large, public institution and has turnover due to retirement and competition, our Dean and Department Chairs have used data analytics as a strategic priority to hire new faculty in this area. These new hires can have the greatest value in enhancing the major via course creation and teaching. Another one of our strengths is the ability to attract highly qualified data analytics adjuncts.

The Provost also helped the effort by offering funding for a speaker series and the business analytics group won one of the awards. Each presenter – textbook authors (Forest Provost of Provost and Fawcett (2013)), course creators (David Schuff (Schuff 2016)), and researchers – engaged with our interdisciplinary audience and this aided considerably in the sharing of information and course ideas within the school. Also, the Vice Chancellor of Research has organized a university-wide task force on data analytics where business professors share ideas and research opportunities with computer science, biology, and nursing professors.

With regard to the diffusion of knowledge and general faculty engagement, the author suspects that Data Analytics will take a similar path to the one that our Digital Marketing program followed a few years earlier. First the school created the courses and the program (most department faculty became **aware** of the program but were uninvolved). Next came an increase in the number of students obtaining internships in the area (faculty began to observe the area growing in importance and began **exploring** the analytics area by reading articles). Department faculty **commitment** was achieved only after they saw the industry environment changing and many of their fellow researchers beginning to combine the new area with their existing discipline (Wymbs, 2011).

One final note: new programs are often like new products, and new programs need to be sold to students. The salaries and projected profession growth rates highlighted in Appendix A, the references to the data analytics track in pre-business introductory courses (especially by faculty who also teach data analytics courses), the industry speakers, and the offering of non-degree data analytics related programs are all good starting points with regard to encouraging student awareness and exploration. Once students commit and take the first data analytics course, real-world applications using industry data re-enforce the relevance of the major, and obtaining documentable skills helps students sell themselves during internship and job interviews.

The author hopes that many more programs will begin to offer data analytics courses and majors and can use what is provided here to guide their development.

9. REFERENCES

AACSB. (2016). Retrieved August 11, 2016, from https://datadirect.aacsb.edu/public/profiles/search.cfm?#results.

ACM/IEEE – IT. (2008). Information Technology Undergraduate Curriculum Model. *Association for Computing Machinery*. Retrieved August 11, 2016, from http:/www.acm.org/education/curricula/IT2008%20Curriculum.pdf.

Agarwal, R., Bapna, R., Goh, K. Y., Ghose, A., Shmueli, G., & Slaughter, S. (2014). Does Growing Demand for Data Science Create New Opportunities for Information Systems? *Proceedings of the Thirty-Fifth International Conference on Information Systems (ICIS),* Auckland, New Zealand. 4697-4703.

ASU. (2016). Retrieved August 10, 2016, from https://wpcarey.asu.edu/undergraduate-degrees/business-data-analytics.

Baskerville, R. & Wood-Harper, A. T. (1996). A Critical Perspective on Action Research as a Method for Information Systems Research. *Journal of Information Technology*, 11(3), 235-246.

BHEF. (2016). About Business Higher Education Forum. Retrieved August 10, 2016, from http://bhef.com/about/.

Bloom, B. S. (1956). *Taxonomy of Educational Objectives*. Boston, MA: Allyn & Bacon.

Borin, N. & Metcalf, L. (2010). Integrating Sustainability into the Marketing of Curriculum: Learning Activities that Facilitate Sustainable Marketing Practices. *Journal of Marketing Education,* 32(2), 140-154.

Burning Glass Technologies (BGT). (2013). *Survey: Report on New York Financial Services Industry Jobs: Data Analytics, Risk Management, Cyber Security, and Social and Mobile Technologies*. (Unpublished Survey for BHEF).

Burning Glass Technologies (BGT). (2015). *Survey*: *Analytical Skills Required for the Finance Industry*. (Unpublished Survey for BHEF).

Chancellor. (2015). Retrieved August 10, 2016, from http://www.baruch.cuny.edu/registrar/documents/September2015.pdf.

Chancellor. (2016). Retrieved August 10, 2016, from http://www.baruch.cuny.edu/registrar/documents/January2016.pdf.

Christensen, C. (1999). *Innovation and the General Management*. New York. Irwin McGraw-Hill.

Colleges. (2016). Retrieved August 11, 2016, from http://datascience.community/colleges.

Conference. (2014). Retrieved August 11, 2016, from http://www.iab.com/events/iab-mobile-marketplace-2014/.

Data Society. (2016). *Why Take Our Courses*. Retrieved August 11, 2016, from http://data.fitbasemedia.com/why-take-our-courses/.

Goh, T. & Sun, P. (2015). Teaching Social Media Analytics: An Assessment Based on Natural Disaster Postings. *Journal of Information Systems Education*, 26(1), 27-36.

Gorman, M. & Klimberg, R. (2014). Benchmarking Academic Programs in Business Analytics. *Interfaces*, 44(3), 329-341.

Heinz. (2016). *Data Analytics at Heinz College*. Retrieved August 11, 2016, from http://www.heinz.cmu.edu/data-analytics-at-heinz-college/index.aspx.

Hienerth, C., Lettl, C., & Keinz, P. (2014). Synergies among Producer Firms, Lead Users, and User Communities: The Case of the LEGO Producer–User Ecosystem. *Journal of Product Innovation Management*, 31(4), 848–866.

Hill, S. & Kline, D. (2014). Teaching “Big Data” in a Business School: Insights from an Undergraduate Course in Big Data Analytics. *Proceedings of the Information Systems Educators Conference*, Baltimore, Maryland, 1-7.

Informs. (2016). Retrieved August 11, 2016, from https://www.informs.org/About-INFORMS/What-is-Analytics.

Klimberg, R & McCullough, B. D. (2013). Business Analytics—Today’s Green? In Lawrence, K.D. and Klimberg, R. (eds.) *Contemporary Perspectives in Data Mining* (Information Age Publishing, Charlotte, NC), 47–60.

Koch, H. & Kayworth, T. (2009). Partnering with the Majors: A Processing Approach to Increase IS Majors. *Journal of Information Systems Education*, 20(4), 439-449.

Koohang, A., Riley, L., Smith, T., & Floyd, K. (2010). Design of an Information Technology Undergraduate Program to Produce IT Versatilists. *Journal of Information Technology Education,* 9, 99-112.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Hung Byers, A. (2011). Big Data: The Next Frontier for Innovation, Competition, and Productivity. *McKinsey Global Institute*. Retrieved August 10, 2016, from http://www.mckinsey.com/business-functions/business-technology/our-insights/big-data-the-next-frontier-for-innovation.

Miller, L. (2016). Retrieved August 10, 2016, from http://community.mis.temple.edu/mis0855sec003fall15/files/2015/08/MIS0855-Syllabus-Fall-20151.pdf.

Mills, R., Velasquez, N., Fadel, K., & Bell, C. (2012). Examining IS Curriculum Profiles and the IS 2010 Model Curriculum Guidelines. *Journal of Information Systems Education*, 23(4), 417-428.

Provost, F. & Fawcett, T. (2013). *Data Science for Business*. Cambridge:. O'Reilly.

PWC. (2015). Data Driven: What Students Need to Succeed in the Rapidly Changing Business World. Retrieved August 10, 2016, from http://www.pwc.com/us/en/faculty-resource/assets/pwc-data-driven-paper-feb2015.pdf.

Schiller, S., Goul, M., Iyer, L., Sharda, R., & Schrader, D. (2014). Panel: Build Your Dream (not just Big) Analytics Program, *Proceedings of the Twentieth Americas Conference on Information Systems (AMCIS),* Savannah, Georgia. 2191-2193.

Schuff, D. (2016). Presentation on Data Analytics. Baruch College, April 29, 2016.

Surendra, N. & Denton, J. (2009). Designing IS Curricula for Practical Relevance: Applying Baseball's "Moneyball" Theory. *Journal of Information Systems Education*, 20(1), 77-85.

Tidd, J. & Bessant, J. (2013). *Managing Innovation: Integrating Technological, Market and Organizational Change*. West Sussex, UK.: Wiley.

Topi, H. (2016). Advancing Data Science Education Through a Transdisciplinary Education. *Opinion: IS Education 2016,* 7(1*)*.

Wang, Y. (2015). Business Intelligence and Analytics Education: Hermeneutic Literature Review and Future Directions in IS Education. *Proceeding of Twenty-First Americas Conference on Information Systems (AMCIS)*, Puerto Rico, 3193-3202.

Wilder, C. R. & Ozgur, C. O. 2015. Business Analytics Curriculum for Undergraduate Majors. *INFORMS Transactions on Education,* 15(2), 180-187.

Wixom, B., Ariyachandra, T., Douglas, D., Goul, M., Gupta, B., Lyer, L., Kulkarni, U., Mooney, J. G., Phillips-Wren, G., & Turetken, O. (2014). The Current State of Business Intelligence in Academia: The Arrival of Big Data. *Communications of the Association for information Systems,* 34, 1-13.

Wymbs, C. (2011). Digital Marketing: The Time for a New "Academic Major" Has Arrived. *Journal of Marketing Education,* 33(1), 93-106.

Wymbs, C. (2014). Data Engineering & Science: The Foundation for a New Marketing Major. *Marketing EDGE Direct/Interactive Marketing Research Summit*, San Diego, CA.

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APPENDICES

Appendix A – Careers in BI/BA

Career	Growth Rate	Medium Salary
Business Intelligence Analysts		$81,140
Clinical Data Managers	13.07%	$75,560
Clinical Research Coordinators	15.45%	$115,730
Compliance Managers	7.32%	$100,890
Computer and Information Research Scientists		$102,190
Computer and Information Systems Managers	16.90%	$120,950
Computer Network Architects		$91,000
Computer Systems Analysts		$79,680
Data Warehousing Specialists		$81,140
Database Administrators		$77,080
Database Architects		$81,140
Geospatial Information Scientists and Technologists		$81,140
Information Security Analysts		$86,170
Intelligence Analysts	16.63%	$74,300
Investment Fund Managers	7.32%	$100,890
Network and Computer Systems Administrators		$72,560
Regulatory Affairs Managers	7.32%	$100,890
Software Developers, Applications		$90,060
Software Developers, Systems Software		$99,000
Statisticians	13.07%	$75,560

*Data obtained from the Occupational Information network (O*NET) under sponsorship of the U.S. Department of Labor/Employment and Training Administration (USDOL/ETA) and adapted from https://wpcarey.asu.edu/undergraduate-degrees/business-data-analytics

Appendix B – Undergraduate Degree Programs in Data Science/Analytics (as of 5/1/2016)

School	Major	Department	M.S. Program	Region
Arizona State University	Bus. Data Analytics	Business	Yes	West
Arkansas Tech University	Bus. Data Analytics	Business	No	South
Auburn University	Data Science	Business	Yes	South
Baruch College/City University NY	Data Analytics	Business	Yes	Mid-Atlantic
Becker College	Data Science	Data Science	No	New England
Case Western Reserve University	Data Science	Data Science	Yes	Mid-West
College of Charleston	Data Science	Computer Science	No	South
Elon University	Information Science	Computer Science	No	South
ENSAE Paris Tech	Data Science		No	France
Florida Polytechnic University	Big Data Analytics	College of Inn & Tech	No	South
George Mason University	Computation D.S.	Physics/Astronomy/CS	Yes	South
Hong Kong University	Risk Mgmt. & Bus Int.		No	Hong Kong
Luther College	Data Science	Computer Science (CS)	No	Mid-West
Massey University	Data Science		Yes	New Zealand
Miami University (Ohio)	IS & Analytics	Business	No	Mid-West
New York University	Applied D.A. & Visualization	School of Professional Studies	Yes	Mid-Atlantic
Northern Kentucky University	Data Science	Computer Science	No	South
The Ohio State University	Data Analytics	Interdisciplinary	Yes	Mid-West
Saint Mary's University (Texas)	Data Analytics	Business	No	South
Sangmyung University	Big Data Science		No	Korea
Southern New Hampshire University	Data Analytics	Online	Yes	New England
TU Dortmund	Data Anal. & Mgmt.	Statistics	Yes	Germany
University College Dublin	Business Analytics	Business	Yes	Ireland
University of California - Irvine	Data Science	Statistics	Yes	West
University of Derby	Analytics / D.S.		Yes	Great Britain
University of Iowa	Business Analytics	Business	Yes	Mid-West
University of Michigan - Ann Arbor	Data Science	Electrical Engineering / CS	No	Mid-West
University of Minnesota - Duluth	Retail Mkt. Analytics	Business & Economics	No	Mid-West
University of Nebraska - Omaha	Data Science	Math	Yes	Mid-West
University of Nottingham	Data Science	Computer Science	No	Great Britain
University of Rochester	Data Science	Interdisciplinary	Yes	Mid-Atlantic
University of San Francisco	Data Science	College of Arts & Sciences	Yes	West
University of Warwick	Data Science		Yes	Great Britain
Virginia Polytechnic Institute	Comp. Model & D.S.	College of Science	No	South
Winoma State University	Data Science	Math & Statistics	No	Mid-West
Worcester Polytechnic Institute	Data Science	Data Science	Yes	New England

Source: Adapted from http://datascience.community/colleges

Appendix C

Business Analytics Majors and Minors*

I. New CIS Program: BBA in Computer Information Systems Track in Data Analytics

Rationale: Analytics, driven by large amounts of data and computing resources, is recognized as a source of value and competitive advantage. Analyzing large data sets, including both structured and unstructured data—often referred to collectively as big data—is becoming a critical basis of competition, underpinning new waves of improved decision making and innovation. Organizations around the world are struggling to develop the know-how to aggregate, analyze, and monetize the growing surge of available data. The new track – Data Science and Analytics - would provide a strong foundation in technology, statistics, and quantitative modeling that is needed to develop business intelligence and drive organizational decision-making.

Core Courses

- Programming for Analytics** (52) or Object-Oriented Programming 1** (1676)
- Database Management Systems 1** (125)
- Data Mining for Business Analytics** (61)
- Data Warehousing for Analytics** (39)

Elective Course

Choose four (4) courses of 3 credits each from the following, at least one of which should be a CIS course and one should be a STA/OPR course.

- Business Intelligence
- Programming for Analytics or Object-Oriented Programming 1**
- Introduction to Semantic Technologies**
- Data Visualization
- Business Statistics II**
- Regression and Forecasting Models for Business
- Quantitative Decision Making for Business I**
- Quantitative Decision Making for Business II
- Marketing Analytics**
- Marketing and Web Analytics and Intelligence**
- Text Analytics

* Chancellor, (2015)

** Course offered in Fall 2016. Also, the number of students registered by mid-August 2016 for Fall 2016 core Data Analytics courses are indicated by the numbers in parentheses.

Appendix D – Learning Goals and Proficiency Exercises for New Data Analytics Courses

Courses	Learning Goals	Task/Exercises
Programming for Analytics (New Core)	• Demonstrate literacy in practical data science (including use of Python programming language) in enterprises • Identify challenges and opportunities that pertain to programming for Data Analytics • Develop programs in a suitable programming language (example – python) that help in data analytics.	Perform programming assignments to analyze various environments that are suitable for development, selection and installation of a Python development environment. Also, perform a group project to analyze a Data Analytics problem and design and implement a Python based solution including writing efficient and error-free code.
Data Mining for Business Analytics (New Core)	• Apply statistical and computational techniques underlying data mining and business analytics to help business decision making • Use appropriate tools in developing data mining solutions • Interpret results in terms of original business problems that led to the collection of the data	Identify the specific business problem to be solved and select the appropriate data-mining tool to provide insight. Interpret the relevant output from the data mining techniques to aid business decisions.
Data Warehousing for Analytics (New Core)	• Translate business needs and drivers into IT requirements for business intelligence systems. • Use the supporting technologies and data models for business intelligence including the process of and techniques for transforming business transaction data into appropriate analytic structures • Explore state-of-the-art solutions for building and managing large data warehouse systems • Discuss appropriate modeling approaches for a variety of industry specific requirements such as healthcare, banking, insurance, on-line advertising, and others • Develop a complete business intelligence system in a team setting using all of the tools and techniques presented during the course.	Learn through projects advanced skills to effectively design, develop, implement and manage medium to large-scale data warehouse systems. Analyze business requirements across multiple industries and address these requirements with appropriate data warehousing and analytics technologies.
Business Intelligence (New Elective)	• Articulate modern concepts, theories, and research in the field of Business Intelligence (BI) • Discuss how technologies that enable BI can be applied in organizational settings • Discuss the various BI practices including knowledge integration, sourcing and managing BI solutions. • Discuss the social and ethical issues related to the use of Business Intelligence technologies in organizations • Describe the various careers that relate to Business Intelligence.	Perform a group project to identify and apply BI tools for use in Decision Support. Use various data analytics (descriptive, predictive, and prescriptive) techniques in creating the enterprise solution.

Data Visualization (New Elective)	• Apply the major concepts in visualization design Apply perception and cognition principles in visualization • Transform large datasets for visual displays using various representation techniques • Critique various visualization representation and interaction techniques.	Apply best practices to identify visualization design principles for various types of data to address specific business problems. Perform via projects solutions using appropriate technologies to visually represent large datasets and explain how this helps in interpretation of data. Also, present these solutions providing compelling arguments for suitability of visualizations for various contexts.
Introduction to Semantic Technologies (New Elective)	• Apply the concept and structure of the semantic web technology • Apply the concepts of metadata, representation of knowledge for machine processing • Build ontology in various application domains for problem solving • Describe ontology in RDF and OWL by using different notations including XML-based syntax • Describe inferences with RDF and OWL • Integrate existing ontologies.	Analyze application cases in data integration, data exchange, knowledge management, e-learning, and web services and map and combine heterogeneous data and knowledge by ontology integration
Marketing Analytics (New Elective)	• Apply statistical and computational techniques for marketing problems using Excel add-ons • Use appropriate tools in developing marketing data and analytics solutions • Interpret results in terms of original marketing business problems that led to the collection of the data • Report marketing analytics results such that industry managers not familiar with analytics can understand the analysis and recommendation.	Solve a case with data analysis using Excel add on for specific marketing problems. Interpret statistical results to propose a solution and plan of action to the company in the case. Communicate the solution orally and in a written business memo.
Text Analytics (New Elective)	• *Understand* the basic statistical methods used to process unstructured and semi-structured text documents such as CHAID and CART and apply the basic understanding of predictive models for processing unstructured text and text surveys, including regression, classification trees • *Test* appropriate tools in developing marketing data and analytics solutions • *Identify* Native Bayesian Networks used to *solve* highly complex business problems • *Operate* Sentiment Analysis software on a variety of business documents to *generate* business insights.	Prepare and analyze unstructured textual information and demonstrate practical applications of Text Analytics methods to identify key themes and hidden meaning from unstructured data (Chancellor, 2015, 2016).

STATEMENT OF PEER REVIEW INTEGRITY

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