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INFORMATION SYSTEMS EDUCATION JOURNAL

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Business Analytics in Practice and in Education: A Competency-based Perspective

Stanislav Mamonov
Stanislav.Mamonov@montclair.edu

Ram Misra
Ram.Misra@montclair.edu

Rashmi Jain
Rashmi.Jain@montclair.edu

IOM Department, School of Business
Montclair State University
Montclair, NJ 07043

Abstract

Business analytics is a fast-growing area in practice. The rapid growth of business analytics in practice in the recent years is mirrored by a corresponding fast evolution of new educational programs. While more than 130 graduate and undergraduate degree programs in business analytics have been launched in the past 5 years, no commonly accepted model of business analytics curriculum yet exists. Drawing on competency-based curriculum design literature, we take the first steps towards initiating a debate on the model curriculum in business analytics. We analyze a sample of business analytics job announcements from different industries and identify a preliminary set of business analytical competencies sought in practice. Further, we examine six existing graduate programs in business analytics, which reveal divergent approaches to business analytics curricula. These institutions were selected since they offered a graduate degree program in business analytics for at least two years. Our findings indicate that there are significant variations in the program structure in terms of program length (10 to 18 months) and flexibility (electives comprise 0 to 37% of the course work). We also found that the programs vary greatly in the coverage of both traditional analytics and the new emergent technologies and analytical methods. We conclude with a commentary on the emergent trends in business analytics in practice and the opportunities presented by these trends for the academia.

Keywords: business analytics, competency-based curriculum.

1. INTRODUCTION

Technology trends lead to a growing volume of available data

The convergence of several technological trends precipitated a rapid increase in the volume, velocity and variety of data that is now available to businesses. The first trend leading to an increasing volume of data is the miniaturization of computing technology, which facilitated pervasiveness of the embedded systems and mobile computing. Global smartphone shipments surpassed computer shipments in 2013 - over 1 billion smartphones were shipped worldwide (Hornyak, 2014). Modern phones feature multicore processors, memory and storage

capacity that would have been the envy of the desktop computers not so long ago. Smartphones also commonly feature microphones, cameras, global positioning systems and accelerometers among other sensors, which can generate immense amounts of data potentially available for capture and analysis. The second complementary trend responsible for the increasing volume of available data is the continuous evolution of storage technology, increasing capacity accompanied by decreasing prices (McLellan, 2014), which enables capture and storage of a growing volume of data, much of which originates from mobile devices.

The third major trend contributing to the increasing volumes of available data is the coevolution of ubiquitous connectivity and social media, leading to the rapid growth in content creation, management, and dissemination. Empowered by smartphones, nearly anyone can capture pictures and videos, and quickly distribute the content. Content sharing statistics from popular social media sites illustrate this trend. Over 100 hours of video are uploaded to YouTube every minute (YouTube, 2014) and Facebook users share over 300 Petabytes of data each month (Traverso, 2013). The convergence of technological trends has led to a massive increase in the volume of data. IBM estimates that 90% of all available data was generated in the past two years and the trend is expected to continue with more data being generated in the coming years (IBM, 2013).

Data creates business opportunities

The availability of new data sources creates opportunities for business process optimization and, in some cases, for a complete reengineering of the way that business is done (Davenport, 2006). For example, customer feedback, one of the most valuable sources of information for businesses, historically was difficult and expensive to obtain. Social reviews posted on Yelp, TripAdvisor and other services now provide invaluable customer feedback information for business managers, pinpointing business strengths and areas for improvement. Social reviews generally follow closely in time with the actual consumer experiences and they are available to business managers at virtually zero cost. Marginal improvements in business efficiency can have a strong impact on business profitability (Soteriou & Zenios, 1999). It was estimated that in 2013 only 22% of the information in the digital universe was a candidate for analysis and less than 5% of that was actually analyzed. By 2020, the useful percentage is projected to grow to more than 35%, mostly because of the growth of data from embedded systems (IDC, 2014). Consequently industry thirsts for people who are able to turn new data into actionable business insights. McKinsey Global Institute estimates that by 2018 the industry will face a shortage of 1.5 million managers with data analytical skills able to translate analytical insights into practice (Manyika, Chui, Brown, Bughin, Dobbs, Roxburgh, 2011). McKinsey further projects that the industry will face a shortage of 140,000 to 190,000 people with deep data science expertise capable of leveraging large datasets.

Academic programs in business analytics

The growing need for business analytical skills has been recognized in academia. Over 130 academic programs in business analytics have been launched between 2007 and 2012 (Wixom et al., 2014). To the best of our knowledge, no model curriculum for programs in business analytics exists at present at either undergraduate or graduate level. Development of model curricula is commonly done by associations and professional societies, e.g. AIS, ACM, IEEE, which integrate input from academic institutions as well as industry experts (Bell, Mills, & Fadel, 2013; Carlsson, Hedman, & Steen, 2010). The development of a model curriculum for business analytics requires a broad coordinated effort among academia and practitioners and it is therefore outside of the scope of the current study. However, we take the first steps towards initiating a discussion concerning the structure of a model business analytics curriculum. We approach this topic from the point of view of competency-based curriculum design.

Competency-based curriculum development proceeds by 1) identifying a common set of skills which are in demand in practice and 2) development of an academic curriculum that empowers the graduates with the corresponding skillset (Bowden, 2004). Competency-based curriculum design has been applied in the development of graduate (Gorgone, Gray, & Stohr, 2006) and undergraduate curricula (Topi & Valacich, 2010) in Information Systems. In this study we take the initial steps of identifying a preliminary skillset associated with business analytics in practice. Further, we review the graduate business analytics curricula at several universities in the New York City metro area. We conclude with a commentary on the evolution of business analytics in practice and the

opportunities for educational programs in business analytics.

2. BUSINESS ANALYTICS IN PRACTICE

Business analytics is commonly defined as skills, technologies, applications and practices for continuous iterative investigation of past business performance to gain insight and drive business planning (Beller & Barnett, 2009). To identify the skillset commonly expected for business analytics practitioners, we conducted a search of open position announcements using Indeed.com, a specialized search engine which indexes job postings across numerous company web sites as well as job posting aggregators. We used the keyword "business analytics" to identify open positions in the New York City metro area. We examined the job listings which were returned by the Indeed search engine and after iterative evaluation decided to retain a relatively short list of positions which 1) were offered at large established companies and 2) exemplified the skillset commonly expected in the industry for similar positions. Our rationale for focusing on the large established corporations is grounded in the expectation that large companies have more established business processes and more clearly defined job functions compared to smaller, less established companies (Humphrey, 1988). Our decision to focus on a limited number of representative positions stems from the observation that while specific industries and companies may have very distinct jobs requirements, our goal is to identify a common set of skills that is frequently required across different companies and industries. The positions selected for our analysis include the following:

- Data Visualization Consultant (Accenture)
- Data Analytics Manager (Deloitte)
- Business Intelligence Analyst (UBS)
- Compliance Office Analyst (Citibank)
- Data & Analytics Consultant (Accenture)
- Loan Operations Business Analyst (Capital One)
- Business Intelligence Architect (Nike)
- Customer Intelligence Analyst (PSEG)

Job descriptions posted by companies follow various formats, but they generally list the required skills. In order to develop a matrix representation of common skills required by each position, we draw on an often cited view of business analytics in practice, which suggests that business analytical skillset lies at the intersection of expertise from three domains 1) the specific business domain, 2) technical data management and programming expertise and 3) applied statistics. Figure 1 summarizes this view in a Venn diagram modeled after (Conway, 2013).

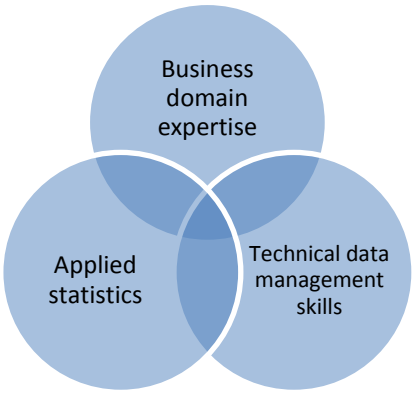

Figure 1. Business analytics skillset

The skill requirements across a representative set of positions are summarized in Table 1 in the Appendix. Our evaluation of the job requirements along the three domains in Figure 1 suggests that applied statistical skills required by the companies encompass both a theoretical understanding of statistical methods, as well as practical knowledge of software packages commonly used for statistical analysis – primarily SAS and R software. The job descriptions commonly require familiarity with regression modeling techniques. Application of regression analysis requires understanding of inherent assumptions underlying the regressions, and necessitates foundational statistical knowledge of distributions, sampling and statistical inference. Though not all job postings explicitly stated this requirement, we inferred the need for foundational statistical knowledge wherever the position required regression analysis expertise.

Data mining is a broad concept that encompasses many data model design and analytical techniques which generally include regression analysis among them (Fayyad, Piatetsky-Shapiro, & Smyth, 1996). In our analysis we separated regression skills from the more advanced data mining methodologies, e.g. decision trees, neural networks, support vector machines as well as ensemble modeling techniques. Further, we also separately evaluated job requirements for text analytical skills, because analysis of textual data is a unique domain within data mining practice with

specialized expertise related to processing and modeling of textual data (Aggarwal & Zhai, 2012). Considering that 80% of the world's data today is unstructured – these skills set are becoming extremely important.

The ability to locate, extract and prepare data for analysis is foundational for business analytics in practice. The required stated technical data management skills among the reviewed job postings span the range from the basic structured query language (SQL) competency in popular relational database management systems (RDBMS) to proficiency with large data set analysis leveraging Hadoop infrastructure. While SQL, RDBMS and data warehousing skills are nearly universally required across the positions which we reviewed, a growing number of positions also require competency with key-value stores, most commonly exemplified by Hadoop implementations in practice. Data warehousing job requirements often specifically call for experience with data extraction, transformation, loading (ETL) and cleaning. Further, two of the eight positions in our sample explicitly required expertise with Python programming language as the development platform for performing data processing and analysis.

Data visualization expertise was nearly universally required by the positions, which we included in our analysis. Data visualization represents an important area of practice. Virtually all positions in our set listed Tableau software as the dominant tool for data visualization, but several positions also suggested Qlikview as another potential software choice for data visualization. All positions emphasized the importance of soft skills: effective communication and presentation as well as the ability to work in groups, highlighting the fact that effective business analytics in practice often requires group collaboration and effective communication of insights across the enterprise. These skills become important in influencing the decision to implement the results of analytical exercise/analytics team.

In addition to specific knowledge of statistical methods and technical skills every position also included business domain specific expertise which qualified an ideal job candidate. These requirements are detailed in Table 2.

Position (Company)	**Industry specific requirements**
Data Visualization Consultant (Accenture)	Industry experience: financial services, healthcare, government
Data Analytics Manager (Deloitte)	Enterprise risk management, risk reporting, financial & regulatory reporting
Business Intelligence Analyst (UBS)	Securities research
Compliance Office Analytics (Citibank)	Anti-money laundering regulation & compliance
Data & Analytics Consultants (Accenture)	Industry experience: financial services, healthcare, high tech, government
Loan Operations Business Analyst (Capital One)	Financial auditing & risk management
Business Intelligence Architect (Nike)	High volume consumer data
Customer Intelligence Analyst (PSEG)	Customer operations/ experience

Table 2. Business domain specific expertise.

2. BUSINESS ANALYTICS CURRICULA

In the next step of our analysis we examined the curriculum structure of graduate programs in business analytics offered at several universities located in the New York metro area. In selecting the programs to be included in our analysis we focused on institutions, which have offered a graduate degree program in business analytics for at least two years. One exception to this requirement was the new program at New York University which officially launched in May 2014 (NYU, 2014). Our rationale for including the new degree program at NYU is grounded in that NYU piloted the courses comprising the new program over two years prior to launch. The new program represents a unique curriculum structure in business analytics education that may be of interest to universities looking to build a business analytics curriculum.

In reviewing the business analytics programs we specifically examined the required courses that are included in each program as well as the

range of elective courses which are available. The summaries below provide the list of core and elective courses for each program that we examined. The universities are listed in alphabetical order. It is important to note that all academic programs evolved over time and the summaries in the table below present the information which was available on the universities' web sites in June 2014.

Fordham University

Degree: MS in Analytics
Program structure: 30 academic credits (3 semesters)

Required courses:
- Database management
- Data warehousing
- Data Mining for business
- Business analytics for managers
- Text analytics
- Web analytics
- Business performance & Risk management

plus 3 electives.

New Jersey Institute of Technology

Degree: MS in Information Systems with concentration in Business Analytics
Program structure: 10 courses, 1.5 years

Required courses:
- User Experience Design
- Data Analytics for IS
- Business Process Innovation
- System Analysis & Design
- Enterprise Database Management

+1 of the following:
- Information Retrieval
- Transaction Mining and Fraud Detection
- Web Mining

Electives:
- Data Management
- Business Decision Making
- Security & Network Management
- Web Systems

New York University

Degree: MS in Business Analytics
Program structure: 14 courses, 10 months.

Required courses:
- Social Media and Digital Marketing Analytics
- Foundations of Statistics Using R
- Prediction
- Data Mining for Business Analytics
- Data Driven Decision Making
- Network Analytics
- Decision Models
- Operations Analytics
- Advanced Decision Models
- Data Visualization
- Special Topics in Analytics: Revenue Management & Pricing
- Strategy, Change and Analytics
- Market Modeling
- Capstone

Rutgers University

Degree: Masters of Business & Science in Analytics
Program structure: 18 credits in science + 19 credits in business

Required courses:
- Fundamental of Analytics
- Advanced Analytics & Applications
- Regression Analysis

+1 course from
- Database Design and Management
- Database Systems
- Database System Engineering
- Advanced Database Systems

+1 course from
- Introduction to Parallel and Distributed Computing
- Parallel and Distributed Computing
- Programming Methodologies for Numerical Computing and Computational Finance
- Applications of Parallel Computers

+3 electives

Stevens Institute of Technology

Degree: MS in Business Intelligence and Analytics
Program structure: 36 academic credits, 1.5 years

Required courses:
- Financial Decision Making

Strategic Data Management Data Warehousing and Business Intelligence Process Analytics and Optimization Financial Enterprise Risk Engineering Multivariate Data Analytics Experimental Design Knowledge Discovery in Databases Statistical Learning & Analytics Social Network Analytics Web Analytics Industry practicum
University of Connecticut Degree: MS in Business Analytics and Project Management. Program structure: 8 required courses + 3 electives, 1.5 years. Required courses: Business Analytics: Business Process Modeling and Data Management Predictive Modeling Business Decision Modeling Data Mining and Business Intelligence Project management: Introduction to Project Management Project Leadership and Communications Project Risk and Cost Management Advanced Business Analytics and Project Management Electives: Real-time Enterprise Data Integration and Audit Data Analytics with R Adaptive Business Intelligence Big Data Analytics with Hadoop Ethical and Legal Issues in Project Management Managing International Development Projects Agile Project Management Graduate Field Study Internship

Table 3. Business Analytics Programs.

Examination of the business analytics curricula across the six graduate programs yields a number of observations. First, there is a significant variation in the program length and flexibility. The NYU program is estimated to require 10 months to complete, while the programs at NJIT, Stevens Institute of Technology and the University of Connecticut require 18 months. In terms of flexibility, the programs offered at Stevens Institute of Technology and the new program at NYU are comprised entirely of required courses. On the other side of the spectrum, the programs offered at other universities offer electives, which comprise up to 37% of the total credits required by the programs. These observations suggest the existence of divergent views on the core business analytics skillset across the educational institutions, which echo the multitude of perspectives that exist in practice on the core business analytics skillset.

Our second observation is that the course allocation across the three areas, which contribute to business analytics: business expertise, applied statistical analysis and technical skills, reveals a diversity of approaches across the academic programs. For example, the MB&S in Analytics program at Rutgers University, allocates 3 core courses to topics on applied statistical analysis. On the other hand, the program at Fordham University incorporates statistical analysis within the broader subjects of business analytics and specific applications of data mining. There is also a difference in terms of the emphasis given to specific tools used for statistical analysis. R software has become the *de facto* standard for statistical analysis in practice (Muenchen, 2014). Two of six programs in our sample offer dedicated courses focusing on the development of R skills. The NYU program in business analytics includes a required course, which covers Foundations of Statistics Using R, and the program at the University of Connecticut offers an elective Data Analytics with R.

There is also significant variation across the programs in our sample in the emphasis placed on data management skills. The programs at Fordham University and Stevens Institute of Technology require two courses in database management and data warehousing. The programs at University of Connecticut and NJIT offer database management courses among the electives, while the program at NYU does not include a course on database management, though related topics are discussed within other courses comprising the program. This might also have to do with how these programs have evolved and the legacy behind them.

Our third observation is that the business analytics programs in our sample often leverage existing institutional strengths. For example, the

program at the University of Connecticut places a strong emphasis on the development of project management skills among the graduates – four of eight required courses within the program focus on project management. NJIT program in business analytics offers another example of leveraging institutional strengths within the business analytics program. The NJIT degree requires students to take courses on user experience and system design as a part of the core analytics curriculum.

Our fourth observation concerns the integration of internships and industry practicums in the curriculum. Industry practicums and internships have long been recognized for their role in improving information systems graduates preparedness for industry employment (Gorgone, Davis, & Valacich, 2003). Two of the six academic programs in our review, NYU and Stevens Institute of Technology, mandate an industry practicum for the degree completion, while the remaining four programs offer it as an elective.

4. DISCUSSION, GAP ANALYSIS AND CONCLUSION

Our analysis of industry business analytics job postings reveals a very healthy market demand for people with business analytical skills. In June 2014, in New York City there were over 5800 business analytics positions paying $60,000 or more with over 1100 jobs paying $140,000 or more. Our examination of the sample of positions offered by large established firms reveals that the companies expect successful candidates to have expertise in data management, applied statistics, and specific business domains, as well as to possess effective communication and presentation skills, and to work well within teams. The job postings universally expect candidates to have RDBMS, SQL and data warehousing competencies. 2 of 8 (25%) positions in our sample also required familiarity with NOSQL and Hadoop. Our findings suggest that the ability to handle (ETL) structured data using traditional relational database technologies remains the core of business analytics in practice, but a growing number of positions also require Big Data expertise exemplified by Hadoop and the newer NOSQL databases.

In terms of applied statistical knowledge, the positions in our sample nearly universally expect the candidates to have foundational statistical knowledge that extends to linear and logistic regression modeling. 6 of 8 (75%) of positions in our sample also required advanced data modeling expertise (decision trees, neural networks, support vector machines, and ensemble modeling techniques). 4 of 8 (50%) positions also required text analytics expertise. These observations suggest that companies are urgently in need of employees who can apply state of the art modeling techniques to make sense of the growing volume of data, including textual data.

Our examination of the specific software skills required by the positions in our sample reveals that Excel remains the workhorse in practice – it is required by 75% of positions in our sample. An important discovery in our analysis is that Tableau software expertise is required by 7 of 8 jobs in our sample. Tableau software offers an intuitive dashboard-driven approach to analytics and it has enjoyed rapid and broad adoption in practice (Pacampara, 2014). It appears that Tableau expertise has become as essential as Excel expertise for business analytics practitioners today.

In assessing the structure of existing graduate-level educational programs in business analytics we find significant variation in the program structure in terms of program length (10 to 18 months) and flexibility (electives comprise 0 to 37% of the course work). We also find that the programs vary greatly in the coverage of both traditional analytics (RDBMS, SQL, data warehousing) and the new emergent technologies (Hadoop, NOSQL) and analytical methods. Our findings echo observations made at a recent discussion in the Special Interest Group on Decision Support Systems (SIGDSS) of business analytics education which lamented the lack of universal inclusion of foundational data analytics skills (RDBMS, SQL, data warehousing) and advocated for the courses covering these areas to be included in the core business analytic curriculum (Wixom et al., 2014).

Our analysis of the business analytics job market also suggests several additional knowledge domains/skills, which may need to be developed within the business analytics curricula. First, we find that text analytics is very much in demand in practice, but is poorly represented within the business analytics curricula.

Text analytics has evolved its own set of analytical techniques and tools (Liu & Murphy, 2013), and business analytics programs would be well served by including a Text Analytics course. Another area requiring further

development is the connection between education and practice. The recent SIGDSS discussion noted that employers are dissatisfied with the practical experience of business analytics graduates (Wixom et al., 2014). In our analysis only 2 of 6 programs require industry practicums. Business analytics appears to be particularly well suited for a closer collaboration between the academia and the industry. Internships and industry practicums would likely help the graduates to transfer their newly acquired business analytical skills from the classroom to practice (Topi & Donnellan, 2014).

In conclusion, our findings are consistent with the previous calls for Information Systems departments to take on the leadership role in addressing the growing industry need for business analytics (Sidorova, 2013). Information Systems are particularly well positioned to develop effective educational offerings in the area of business analytics, because the topics of technology procurement and management, as well as the strategic role of information technology in business have been the traditional focal points for IS in research and education. Our results suggest that while the traditional business analytical technologies (RDBMS, SQL) remain very relevant in practice today, the emergent areas of Big Data analysis (Hadoop, NOSQL) and specialized analytics (text data analysis) present attractive growth areas in practice that need to be addressed within the educational domain as well. A closer collaboration with the industry in developing these offerings would serve well all the stakeholders: students, faculty, the educational institutions and industry.

5. REFERENCES

Aggarwal, C. C., & Zhai, C. (2012). *Mining text data*. Springer.

Bell, C., Mills, R., & Fadel, K. (2013). An Analysis of Undergraduate Information Systems Curricula: Adoption of the IS 2010 Curriculum Guidelines. *Communications of the Association for Information Systems*, *32*.

Beller, M. J., & Barnett, A. (2009). Next generation business analytics. *Lightship Partners LLC, Www. Slideshare. net/LightshipPartners/nextgeneration-Business-Analytics-Presentation*.

Bowden, J. (2004). Capabilities-driven curriculum design. In *Effective learning and teaching in engineering* (pp. 36–47).

Carlsson, S., Hedman, J., & Steen, O. (2010). Integrated curriculum for a bachelor of science in business information systems design (BISD 2010). *Communications of the Association for Information Systems*, *26*.

Conway, D. (2013). THE DATA SCIENCE VENN DIAGRAM. Retrieved from http://drewconway.com/zia/2013/3/26/the-data-science-venn-diagram

Davenport, T. H. (2006). Competing on analytics. *Harvard Business Review*, *84*(1), 98.

Fayyad, U., Piatetsky-Shapiro, G., & Smyth, P. (1996). From data mining to knowledge discovery in databases. *AI Magazine*, *17*(3), 37.

Gorgone, J., Davis, G., & Valacich, J. (2003). IS 2002 model curriculum and guidelines for undergraduate degree programs in information systems. *Communications of AIS*, *11*.

Gorgone, J., Gray, P., & Stohr, E. (2006). MSIS 2006: model curriculum and guidelines for graduate degree programs in information systems. *Communications of the AIS*, *17*(2), 121–196.

Hornyak, T. (2014). 1 billion smartphones shipped worldwide in 2013. *PCWorld*.

Humphrey, W. S. (1988). Characterizing the software process: a maturity framework. *Software, IEEE*, *5*(2), 73–79.

IBM. (2013). Apply new analytics tools to reveal new opportunities. Retrieved from http://www.ibm.com/smarterplanet/us/en/business_analytics/article/it_business_intelligence.html

IDC. (2014). *The Digital Universe of Opportunities: Rich Data and the Increasing Value of the Internet of Things*.

James Manyika, Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, A. H. B. (2011). Big data: The next frontier for innovation, competition, and productivity. *McKinsey Global Institute Report*, *May*.

Liu, M. (Xiang), & Murphy, D. (2013). The Document Explosion in the World of Big Data – Curriculum Considerations. *2013 Proceedings of the Information Systems Educators Conference*, *30*, 1–9.

McLellan, C. (2014). Storage in 2014: An overview. Retrieved from http://www.zdnet.com/storage-in-2014-an-overview-7000024712/

Muenchen, R. A. (2014). The Popularity of Data Analysis Software.

NYU. (2014). NYU - Master of Science in Business Analytics. Retrieved from http://www.stern.nyu.edu/programs-admissions/global-degrees/business-analytics

Pacampara, B. (2014). Why Tableau Software Inc Will Keep Flying in 2014. Retrieved from http://www.fool.com/investing/general/2014/01/29/why-tableau-software-inc-will-keep-flying-in-2014.aspx

Sidorova, A. (2013). Business Analysis as an Opportunity for IS Programs in Business Schools. *Communications of AIS*, *33*, 521–540.

Soteriou, A., & Zenios, S. A. (1999). Operations, quality, and profitability in the provision of banking services. *Management Science*, *45*(9), 1221–1238.

Topi, H., & Donnellan, B. (2014). Moving Toward the Next Generation of Graduate Degree Programs in Information Systems. *Communications of the Association for Information Systems*, *34*(1).

Topi, H., & Valacich, J. (2010). IS 2010: Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. *Communications of the AIS*, *26*.

Traverso, M. (2013). Presto: Interacting with petabytes of data at Facebook. Retrieved from https://www.facebook.com/notes/facebook-engineering/presto-interacting-with-petabytes-of-data-at-facebook/10151786197628920

Wixom, B., Ariyachandra, T., Douglas, D., Goul, M., Gupta, B., Iyer, L., … 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.

YouTube. (2014). Youtube viewership statistics. Retrieved from http://www.youtube.com/yt/press/statistics.html

Appendix

Table 1. A summary of skill requirements for positions in business analytics.

	Data Visualization Consultant (Accenture)	**Data Analytics Manager (Deloitte)**	**Business Intelligence Analyst (UBS)**	**Compliance Office Analytics (Citibank)**	**Data & Analytics Consultants (Accenture)**	**Loan Operations Business Analyst (Capital One)**	**Business Intelligence Architect (Nike)**	**Customer Intelligence Analyst (PSEG)**
Applied statistics								
Distributions, sampling & statistical inference	✓	✓	✓	✓		✓	✓	✓
Linear regression	✓	✓	✓	✓		✓	✓	✓
Logistic regression	✓	✓	✓	✓		✓	✓	✓
Advanced data mining techniques	✓	✓	✓	✓			✓	✓
Text analysis	✓	✓		✓			✓	
Technical skills								
Data storage/extraction								
Relational databases & SQL	✓	✓	✓	✓	✓	✓	✓	✓
Data warehousing	✓	✓		✓	✓	✓	✓	
NOSQL databases	✓				✓			
Hadoop	✓				✓			
Python	✓						✓	
Analytical software								
Excel	✓	✓	✓	✓		✓		✓
SAS	✓					✓		
R							✓	
Tableau	✓	✓	✓	✓	✓	✓		✓
Qlikview	✓	✓			✓			
Soft skills								
Communication & Presentation	✓	✓	✓	✓	✓	✓	✓	✓
Teamwork	✓	✓	✓	✓	✓	✓	✓	✓