A Cross Collegiate Analysis of the Curricula of Business Analytics Minor Programs

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Abstract

In recent years, there has been an explosion in the demand for personnel with analytics skills. Given that the demand for this skill set cuts across so many disciplines, it is a useful addition to any major and an ideal candidate as an academic minor. Furthermore, as the underlying analytics tools and techniques used by data analysts emerged primarily from the business disciplines, the school of business makes an ideal place to house an analytics minor. Given the high demand for business analytics skills and the ubiquitous nature of the analytics field, the question becomes what topics should be included in the curriculum of a business analytics minor? The goal of this research is to answer that question by analyzing the curricula currently offered by a large sample of business analytics minor programs.

Keywords: Business Analytics Knowledge and Skills, Business Analytics Minor Curriculum

1. INTRODUCTION

In recent years, there has been an explosion in the demand for personnel in the field of analytics. Particularly for professionals with the knowledge, skills and competencies required for the methodical exploration and investigation of data. Using descriptive, predictive, and prescriptive statistical tools, analytics professionals support decision making and gain insight into business performance. Ranked second in a Computerworld survey on the most difficult skills to find, analytics expertise is scarce (Computerworld 2018). McKinsey Global Institute reports that the United States could face a shortage of between 140,000 and 190,000 individuals who possess business analytics skills and an additional 1.5 million managers with the skills to implement the results (McKinsey Global Institute 2018). In addition, according to the Bureau of Labor Statistics, employment in the data analytics area is projected to grow by 27 percent by 2022 (U.S. Bureau of Labor Statistics 2018).

An understanding of analytics has the potential to add value to almost any career path as analytics spans across all disciplines and industry sectors. Students with these skills are in high demand in a variety of industries and sectors including accounting, management, marketing, finance, information systems, operations, health care, human resources, engineering, politics, sports, energy, etc. Given that the demand for this skill set cuts across so many disciplines, it is a useful addition to any major and an ideal candidate as an academic minor. Furthermore, as the underlying analytics tools and techniques emerge from disciplines such as management science, operations research, statistics, business intelligence, information systems, and traditional business fields, the school of business makes an ideal place to house an analytics minor.

Given the high demand for business analytics skills and the ubiquitous nature of the analytics field, the question becomes what topics should be included in the curriculum of a business analytics minor? The goal of this research is to answer that question by reviewing, analyzing, and tabulating the curricula currently offered by a large sample of business analytics minor programs. Although Phelps and Szabat's research (Phelps and Szabat, 2015) indicates 73% of academics polled believe a major or minor degree option will be offered by most major business schools in the near future, the minor has gotten little attention.

2. LITERATURE REVIEW

The literature related to data analytics education is still scant and in particular, very little is devoted to the subject of this paper, the data analytics minor. Some of the difficulty in identifying the literature is the lack of uniformity in the use of the terms "business intelligence," "business analytics," and "decision science." Zheng (2018) defined analytics as a catch-all term which is an expansion of business intelligence and which currently refers to the generalized leveraging of information for more strategic decision-making. Likewise, he sees data science as an interdisciplinary field which has evolved from business intelligence, using models and methods to create insights from data. Rostcheck (2016) draws a finer distinction between business intelligence and data science characterizing business intelligence as backwards-looking, analytic, and data base focused and data science as predictive due to its incorporation of hypotheses and modeling. Business/Data Analytics programs are most often housed in business departments and data science programs are typically offered through computer science departments or are interdisciplinary (Philips and Szabot, 2015, p. 2).

Wang (2015) identified 44 research papers that were pertinent by searching Google Scholar for titles of articles published in journals or conference proceedings between 2009 and 2015 using keywords such as "business intelligence" and "analytics education." After retrieving 26 papers, he then used snowballing and citation analysis, suggested by Boell and Cecez-Kecmanovic, to find further relevant literature. As a result, he hand-selected an additional 18 papers that met the criteria. He then categorized the papers into the five research categories they covered. These included: The Current State of Analytics Education; The Role of the Data-savvy Professional; The Design of the Analytics Curriculum; Teaching Cases and Learning Activities; and Skill Sets and Knowledge Domains of Professionals.

Wang identified five areas that were not addressed in the research papers. Firstly, although the perspectives of faculty, students, and practitioners were addressed, feedback from new graduates had not been. Also, learning activities in the curricula seemed to be exploratory or case study in nature but theoretical frameworks or empirical methods for assessing student learning were not discussed. The literature discussed only analytics education in the United States rather than global education. Pedagogical innovations and the design of teaching courses was not given much attention. Finally, there was no articulated framework of knowledge domains and skills sets for the analytics professional.

Phelps and Szabat (2015) surveyed approximately 100 academics with a connection to statistics education to better understand how undergraduate institutions were preparing to develop data analytics programs. The survey questions were developed based upon earlier research by Aasheim, Runter, and Gardiner (2014) and Gorman and Klimberg (2014). These studies found that analytics programs were not just a rebranding of existing curricula but were novel. The programs were heterogeneous and dependent upon expertise of faculty, type of student, and local industry. The authors noted that there was an interest in integrating analytics throughout the curriculum.

Phelps and Szabat (2015) found that 53% of schools did not yet offer an undergraduate major in business analytics or decision sciences and 59% did not offer a minor. Fifty-nine percent offered neither a business analytics or decision science minor but 6% offered both, 6% only at the graduate level and 9% only at the undergraduate level. About 30% of the respondents were considering creating a business analytics or decision science major and 26% were considering a minor. Most programs required only one statistics course and Excel was the software of choice for statistics, R for business analytics. Statistics and Information Systems technology faculty had the greatest involvement in teaching the courses.

Wilder and Ozgur (2015) identified three levels of skills which the data analytics undergraduate curriculum should address. The data scientist should have an advanced degree in a quantitative discipline and a foundation in computer science and mathematics which includes probability and

statistics. Data scientists work on more challenging problems and can find employment as consultants or as part of an internal corporate specialized group. At the next level, the data specialist should understand how data is stored and how to access and analyze it. Data specialists may work in a centralized IT support group or be scattered throughout the functional business areas. At the final level, the business analyst is a data-saavy manager who understands how to identify and frame the business problem or question to be addressed/answered through data analysis. Citing Watson (2013), Wang also maintained that three types of analytics should be addressed: descriptive (what has already happened); predictive (what is expected to happen) and prescriptive (what should happen).

Wilder and Ozgur (2015) suggested that graduate curricula should be used as a model for undergraduate studies and noted that in 2015, there were 49 such programs. They also noted that the Institute for Operations Research and the Management Science (INFORMS) offers a Certified Analytics Professional (CAP) exam which provides a guide for curriculum development. They mentioned that minors and certifications should be considered as other options.

The curriculum they proposed for the business analyst has six major courses and one core course and is organized around five knowledge domains: project life cycle, data management, analytical techniques, deployment, and a functional area. These domains are to be spread across the curriculum rather than provided in individual, specialized courses. For example, traditional business math courses such as calculus and statistics would need to be updated to incorporate these knowledge areas. The six required courses include Data Management (tools such as SQL), Descriptive Analysis (statistics), Data Visualization (key indicators, scorecards, dashboards), Predictive Analytics (advanced statistics), Prescriptive Analytics (Spreadsheet Models), and Data Mining (CRISP-DM). A Practicum and Electives complete the major. They recommended an overall approach which leads the student from the specific (real life problem) to the general (how to use decision trees), to maintain student interest and ensure that students view the coursework as relevant.

Wymbs (2016) referred to the Burning Glass Technologies Report for identifying the skill sets for Data Analytics jobs which included statistical package skills (SPSS, SAS, R) Microsoft PowerPoint and Excel, financial skills such as risk management, some programming skills, and critical thinking and communications skills. He noted that as of 2016, there were 517 data science/data analytics programs of which 374 were Master's programs, 88 Certificate programs, 36 Bachelor's programs, and 10 PhD programs. A query of the AACSB database of 1,500 institutions indicated only 11 undergraduate programs in data analytics and data science but 56 programs in business analytics. Some of these may have also have been implemented by changing just the names of existing courses and programs rather than by truly innovating. Wymbs cited Wang (2015) and Wilder and Ozgur (2015) for the proposition that most business analytics programs are in the Business School, are in their infancy, lack a commonly accepted curriculum model and do not include a design for developing students' professional skills. Unanswered questions include: how many courses should be in a BI/BA major or minor?

Wymbs (2016) also discussed insights provided by the 2015 Business Higher Education Forum Conference attended by investment banks, accounting firms, publishers, tech companies, and the Federal Reserve. Participants preferred "R" and Python as programming languages and indicated that they expected new graduates, particularly accountants, to have data analytics proficiency in ordered to be hired. This led to the author's institution offering a business minor in data analytics and tracks in CIS and Marketing which could be completed within one year. Important ongoing contributions from the business community included real datasets for data mining, internships, case studies, and advice. For schools who want to initiate analytics education earlier, Temple University offers a General Education data analytics course, without prerequisites, which can be used as a model.

Meyer (2015) pointed out that even INFORMS states that there is no consensus as to what constitutes a defined curriculum for data analytics. Meyer sees the subject as multi-disciplinary and described a cross-college undergraduate program, developed at Drake College, wherein the student could earn a data analytics degree in either the College of Arts and Sciences or the College of Business. The core of the program consisted of computer science and statistics along with a specialty area such as marketing or bioinformatics. Meyer concluded that practically speaking, the elements of data analytics are: data/database, statistics, operations research, computer science, and managerial strategy. As these courses already exist, schools who develop a data analytics program add courses such as Data Visualization,

Programming in R, or Customer Sentiment Analysis to establish an immediate presence in the field.

Meyer described the contents of a sample of data analytics programs in the Midwest which included undergraduate, graduate, and certificate programs. Foci ranged from Management, to Information Systems, to Operations Research. In addition, he described a minor at the University of Cincinnati which included two courses in Business Analytics, a course in Data Mining and a course in Spreadsheet Analysis. Elective Courses were far ranging as to topic and included: Forecasting, Data Visualization, Econometrics, Database Design, Financial Modeling, and Marketing Research. He also described a Data Analytics minor at Drake which included two courses in calculus, two courses in computer programming, an introduction to R and SAS, Statistics, Cloud Computing or Database, Machine Learning, and Data Mining or Modeling. Drake has under development a five course "data-savvy" sequence which will be required of all business students, not just those with a special interest in data analytics.

3. RESEARCH METHODOLOGY

This research uses a "grounded theory" approach. The sociologists Barney Glaser and Anselm Strauss developed grounded theory in the 1960's. In the grounded theory approach, conclusions are drawn and theories are produced by analyzing a body of data. In essence, the theories that are produced are "grounded" in the data (Glaser & Strauss, 1967).

For this project, sixty colleges/universities that offer a business analytics minor were randomly selected. Appendix One lists all of the colleges/universities having a program was included in the study. The curriculum for each of the programs was then reviewed, analyzed, and tabulated. For each program, it was determined the number and nature of the prerequisite courses, required courses, and elective courses. A list of the courses was then recorded.

Once the courses were identified, the researchers then reviewed the catalog descriptions of the courses. Based on the catalog descriptions a list of the topics covered was compiled. The results of that compilation are shown in the following section.

4. RESULTS

The analysis of the sixty programs showed that, on average, business analytics minor programs have two prerequisite courses, three required courses, and two electives. However, there was some variation in this pattern as about a third of the programs had no prerequisite courses and about a quarter of the programs had no elective courses. The maximum number of courses in a program in each of the three categories (prerequisites, required, and electives) was four for prerequisites, seven for required courses, and four for number of electives.

The results of the topics covered in the programs have been compiled into three tables. Table 1 shows a listing of all the prerequisite topics covered by all sixty of the business analytics minor programs that were included in the study. The first column lists the topic covered, the second column shows a count of the number of programs that covered that topic, and the third column shows the percentage of the sixty schools that covered that topic. Table 2 shows a list of all required topics for all sixty schools (again, also showing the count of programs and the percentage of schools). Table 3 shows a list of all electives for all sixty schools in the same format.

The tables are self-explanatory but it is worth noting some observations. First, concerning prerequisite topics, the most popular topics are basic statistics and principles of IT/IS/MIS. It appears that most programs believe that knowledge of these topics is important in preparing students for the required courses. A review of table three supports this, as predictive analytics (the branch of advanced analytics which is used to make predictions about unknown future events) and descriptive analytics (a preliminary stage of data processing that creates a summary of historical data) are the most popular required topics and both rely heavily on a knowledge of basic statistics and of the topics covered in an introductory, principles of IT/IS course.

In addition to predictive and descriptive analytics, Database, Data Mining, Basic Statistics (when not a prerequisite), Decision Science / Business Intelligence, Data Visualization, Excel (Spreadsheets), Principles of IS/IT/MIS (again when not a prerequisite), Introductory Computer Programming, Management Science / Operation Management, and Big Data are also popular required topics. It is also worth noting

Prerequisite Topics	Count	Percent
Basic Statistics	32	53%
Principles of IS/IT/MIS	11	18%
Descriptive Analytics	7	12%
Predictive Analytics	4	7%
Introductory Economics	4	7%
Advanced Statistics	3	5%
Excel (Spreadsheets)	3	5%
Calculus	3	5%
Management Science / Operation Mgt	2	3%
Introductory Computer Programming	2	3%
Prescriptive Analytics	1	2%
Decision Science / Business Intelligence	1	2%
Database	1	2%
Marketing (or Marketing Related)	1	2%
Linear Algebra	1	2%
Intro to Business	1	2%

Table 1 Prerequisite Topics Required By Business Analytics Minor Programs

that seven percent of the programs have a required capstone or project oriented topics course.

As would be expected, based on the emphasis of the individual program, electives offered by the various programs are fairly splintered. The most popular elective topics are Marketing (or Marketing Related), Econometrics, Financial Modeling, Database, Data Mining, Decision Science / Business Intelligence, Simulation and Risk Analysis, Supply Chain Management, Management Science / Operation Management, Forecasting, Application Specific Analytics (Travel, Hospitality, Healthcare, Human Resources, etc.), Data Visualization, Statistical Programming or Software, Experiments and Quality Control, Advanced Statistics, Analytics Research, Project Management, Accounting IS, and Big Data.

Required Topics	Count	Percent
Predictive Analytics	43	72%
Descriptive Analytics	37	62%
Database	27	45%
Data Mining	26	43%
Basic Statistics	22	37%
Decision Science / Business Intelligence	17	28%
Data Visualization	14	23%
Excel (Spreadsheets)	14	23%
Principles of IS/IT/MIS	11	18%
Introductory Computer Programming	9	15%
Management Science / Operation Mgt	7	12%
Big Data	7	12%
Advanced Statistics	6	10%
Capstone/Project	4	7%
Econometrics	4	7%
Simulation and Risk Analysis	4	7%
Prescriptive Analytics	3	5%
Systems Analysis and Design	3	5%
Problem Solving	3	5%
SQL	3	5%
Business Process Analysis	3	5%
Marketing (or Marketing Related)	2	3%
Calculus	2	3%
Financial Modeling	2	3%
Statistical Programming or Software	1	2%
Supply Chain Mgt	1	2%
Project Mgt	1	2%
Forecasting	1	2%
Geographic IS	1	2%
Accounting (Managerial or Financial)	1	2%
Ethics	1	2%
Linear Algebra	1	2%
International or Global Related	1	2%

Table 2 Required Topics Covered By Business Analytics Minor Programs

Elective Topics	Count	Percent
Marketing (or Marketing Related)	28	47%
Econometrics	20	33%
Financial Modeling	15	25%
Database	14	23%
Data Mining	13	22%
Decision Science / Business Intelligence	11	18%
Simulation and Risk Analysis	11	18%
Supply Chain Mgt	10	17%
Management Science / Operation Mgt	9	15%
Forecasting	9	15%
Application Specific Analytics	9	15%
Data Visualization	8	13%
Statistical Programming or Software	8	13%
Experiments and Quality Control	8	13%
Advanced Statistics	7	12%
Analytics Research	7	12%
Project Mgt	7	12%
Accounting IS	7	12%
Big Data	6	10%
Introductory Computer Programming	5	8%
Systems Analysis and Design	5	8%
ERP	5	8%
Web Design & Analytics	5	8%
Prescriptive Analytics	4	7%
Geographic IS	4	7%
Principles of IS/IT/MIS	3	5%
Excel (Spreadsheets)	3	5%
Capstone/Project	3	5%
Predictive Analytics	2	3%
Advanced Economics	2	3%
Accounting (Managerial or Financial)	2	3%
Artificial Intelligence	2	3%
Business Process Analysis	2	3%
Descriptive Analytics	1	2%
Calculus	1	2%
Problem Solving	1	2%
Ethics	1	2%
Cyber Security	1	2%
International or Global Related	1	2%
Text Analytics	1	2%
Managerial Analytics	1	2%

Table 3 Elective Topics Covered By Business Analytics Minor Programs

5. SAMPLE BUSINESS ANALYTICS MINOR CURRICULUM

This section introduces a sample business analytics minor curriculum that was developed based on the results of the data collected. It includes the following courses:

Prerequisites:
1. Basic Statistics
2. Principles of IS/IT/MIS
3. Excel (optional)

Required Courses:
1. Business Analytics I
2. Business Analytics II
3. Management Science

Electives (Choose Two):
1. Marketing or Marketing Related
2. Econometrics
3. Intro to Programming
4. Database Management Systems
5. Decision Support Systems
6. Data Visualization
7. Statistical Programming or Software
8. Application specific course

The role of the prerequisite courses would be to prepare the student for the material covered in the minor. The sample curriculum has two required prerequisites, (Basic Statistics and Principles of IS/IT/MIS), and one optional prerequisite (Excel). The Basic Statistics course would cover statistical theories and techniques commonly used in the analysis of business data. Emphasis is on descriptive measures, probability theory, estimation techniques and forecasting methods, hypothesis testing, and time series analysis. The Principles of IT/IS/MIS course topics would include the following: computer hardware and software architecture, organizing data, telecommunications and networks, types of systems and their development, and the role of information technology in business and society. In the Excel course, students will learn to

navigate Microsoft Excel software and become familiar with Excel's features and capabilities.
Once students have fulfilled the prerequisites, the sample curriculum suggests three required courses: Business Analytics I, Business Analytics II, and Management Science. The Business Analytics I course would provide students with the fundamental concepts and tools needed to understand the emerging role of business analytics in organizations. The course would cover managerial statistical tools in descriptive analytics and predictive analytics, including probability distributions, sampling and estimation, statistical inference, and regression analysis. Students would also learn how to communicate with analytics professionals using basic data visualization techniques to effectively use and interpret analytic models and results for making better business decisions.

The second required course, Business Analytics II, would provide students with advanced concepts and tools needed to understand the role of data analytics in organizations. Topics would include forecasting, risk analysis, simulation, data mining, and decision analysis. Emphasis is on applications, concepts and interpretation of results as well as conducting statistical analyses.

The third required course, Management Science, involves strategic conceptualization, decision-making and analysis of processes within the business and its environment. This course introduces quantitative and computing techniques that contemporary managers use to create models representing the business problems they need to solve. The emphasis of this course will be on the integration and development of modeling skills including problem recognition, data collection, model formulation, analysis, and communicating the results. Building logical thinking and quantitative skills are among the objectives of this course.

The elective courses in the sample curriculum help the students develop skills that increase their knowledge of a specialized area within their field. The sample curriculum suggests two electives. The electives offered are shaped by the goals of the program and, at least to start, the available course offerings at the institution. Based on the results of the analysis, a marketing based course, such as e-commerce or e-marketing, and an econometrics course should be included in the electives offered.

For instance, an e-marketing course could examine how analytics, the Internet, and related technologies are transforming the ways in which firms market their products and services. Topics covered would include examination of emerging business models, application of analytics, customer relationship management (CRM), role of data mining and data warehouses, personalization, branding issues, dynamic pricing and price competition, role of the Internet as a communications / advertising medium, distribution through the Internet and e-tailing, and legal and ethical issues.

Econometrics is the application of mathematical and statistical methods and techniques in order to: 1) help understand, analyze, and interpret economic and financial data, 2) test economic and financial hypotheses/theories, and 3) generate predictions about particular economic and financial variables. Econometrics is fundamentally a regression-based correlation methodology used to measure the overall strength, direction, and statistical significance between a "dependent" variable - the variable whose movement or change is to be explained - and one or more "independent" variables that will explain the movement or change in the dependent variable.

Technology based courses are also popular electives in our research pool. These courses help to define the utilization of analytical tools and have the added benefit of most likely already existing in the catalog of IS courses within the business school. For instance, Intro to Programming, Database Management Systems, Decision Support Systems, Data Visualization (any effort to help people understand the significance of data by placing it in a visual context), Statistical Programming or Statistical Software are all courses that help the student understand technologies important to the analytics process.

One last note on electives. In order to tailor the minor program to the student's major, an application specific course is suggested. This course would be housed, and staffed, by the department of the major. For instance, if a student mas majoring in Health Administration, a course called "Analytics for Health Administration" could be offered by the Health Administration department yet count as an elective in the business analytics minor program. Again, this course could come from any major such as Accounting, Travel, Hospitality, Healthcare, Human Resources, etc.

6. CONCLUSION

Given the high demand for business analytics skills and the ubiquitous nature of the analytics field, it is an ideal candidate as an academic minor. This research analyzed the curricula of sixty current business analytics minor programs in order to answer the question as to what courses and topics should be included in the curriculum.

The analysis showed that the ideal business analytics minor would consist of prerequisite courses in statistics and IT/IS principles, and required courses that cover introductory analytics (descriptive, predictive, regression, probability, visualization, etc.) and advanced analytics topics such as forecasting, risk analysis, simulation, data mining, and decision analysis. In addition, a required course in Management Science should be included in the curriculum. Furthermore, this research suggests that the BA minor should include elective courses designed to tailor the program to the individual goals of the student.

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APPENDIX ONE – A LIST OF INSTITUTIONS INCLUDED IN THE STUDY

Ashland University	Southern Methodist University
Auburn University	SUNY Plattsburgh
Baruch College	Temple University
Drexel University	Texas A&M University
Eastern Illinois University	University of Arkansas
Fairfield University	University of Central Missouri
Florida Atlantic University	University of Cincinnati
Florida State University	University of Connecticut
Florida International University	University of Delaware
Georgia Southern University	University of Denver
Hamline University	University of Hartford
James Madison University	University of Idaho
Kent State University	University of Illinois at Chicago
LeMoyne College	University of Maryland
Loyola University	University of Miami
Manhattan College	University of Minnesota
Miami University (Ohio)	University of Nebraska–Lincoln
Northeastern University	University of San Diego
Northern Illinois University	University of San Francisco
Northern Kentucky University	University of Scranton
Northwood University	University of South Dakota
Ohio University	University of Tampa
Old Dominion	University of Tulsa
Pace University	University of Wisconsin
Penn College	Valparaiso University
Purdue University	Villanova University
Rider University	Western Washington University
Sabanci University	Wilkes University
Saint Joseph's University	Xavier University
Santa Clara University	York College of Pennsylvania