

**A FEASIBILITY STUDY AND DEVELOPMENT OF
AN A.A.S. DEGREE IN DATA ANALYTICS**

by

Brad Thompson

An education leadership portfolio submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Education in Educational Leadership

Fall 2017

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AN A.A.S. DEGREE PROGRAM IN DATA ANALYTICS**

by

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DEDICATION

*For my wife, Nicole
my girls, Everleigh and Vivienne
and Annie*

In memory of my Mom

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ABSTRACT

This Educational Leadership Portfolio (ELP) documents my exploratory study of the feasibility of developing a new associate level (A.A.S) degree program. While this study and plan is designed to serve as a guide for any two-year or community college thinking of developing such a program, many of the artifacts in this study are written specifically for Delaware Technical Community College (DTCC). This ELP is comprised of a general overview of the current field of data analytics, an analysis of the national and regional labor markets, a review of how academic institutions are working to meet industry needs, as well as resources and guidelines to help community colleges meet the challenges of developing a new program in the emerging field of data analytics.

Currently, there are less than a handful of academic institutions that are offering an associate degree in data science or analytics. While there are a variety of reasons for this, it is critical that each institution interested in pursuing this venture conduct their own feasibility study, specific to the local area they serve, to see if this program would be realistic and achievable. The purpose of this ELP is to present such a study. Valuable data and perspectives were gained through open dialogue with professional data scientists in the region, local industry representatives, and relevant stakeholders from various academic institutions. Analysis of these data and perspectives led to the conclusion that not only is it feasible for community colleges to start considering associate degree programs in data analytics, but that future trends indicate that these programs will continue to grow in numbers and with positive results.

In addition to exploring the feasibility of a new Data Analytics A.A.S. degree at Delaware Technical Community College, research was also conducted on the specific development of such a program and what it could look like at the institution. The program design was guided by evidence-based instructional design principles. Along with conducting program reviews and case studies of other academic institutions that have developed similar programs, exploratory data was collected on local industry to develop more informed decisions regarding the knowledge, skills, and abilities that a graduate should possess when entering the workforce.

Chapter 1

INTRODUCTION

Problem Overview

In his 2008 speech at the Innovating with Information Conference, Google Chief Economist Hal Varian declared that data science would be the dream job of the next decade. “What is getting ubiquitous and cheap? Data. What is scarce and expensive? The talent to be able to analyze that data and make it tell its story” (Young, Johnson, Chow, & Rosenberger, 2015). As demand for skilled, knowledgeable employees has increased among industries associated with data and analytics, some colleges and universities have started developing and offering programs in data science and analytics.

Delaware Technical Community College (DTCC) is currently among the majority of institutions of higher education that does not offer degree programs or certifications in data analytics. This Educational Leadership Portfolio (ELP) is designed to address that absence by researching industry needs for entry-level positions in the fields of data analytics nationally and regionally, and by proposing a program of study that would be among the first of its kind nationally. This unique associate level degree program is informed by emerging trends in data analytics, industry requirements, current academic standards, and institutional goals.

Organization of Portfolio

To effectively document the process of addressing this problem, the remainder of this ELP is organized to tell the story of what is required and recommended when developing a data analytics associate degree program. First, the problem is addressed in a national and regional context. This chapter describes the growing need of skilled data science workers, along with the critical shortage of such graduates, and how academic institutions are preparing to approach this problem. Also discussed is how Delaware Technical Community College fits into this problem context, as well as how my work on this problem can specifically guide improvement strategies at DTCC. These strategies are presented through guidelines for curriculum development, program characteristics, and evaluation measures. While these strategies have not yet been implemented at the College, what follows is reflection on how these strategies were developed, and how they can be assessed and evaluated once the program is operational. As a closing, the last chapter of the ELP presents an opportunity to reflect on the impact of this process on me as a scholar, problem-solver, and partner in the context of educational leadership. Finally, the appendices contain the research artifacts that were created and utilized to support the key findings and recommendations of this Educational Leadership Portfolio.

Chapter 2

PROBLEM ADDRESSED

Definition of Data Science and Analytics

Data science is the science of planning for, acquisition, management, analysis of, and inference of data through the creation of data products and analysis (De Veaux et al., 2017). This is usually accomplished through some combinations of statistics, computing, and business analysis (Hardin et al., 2015). While the term “data science” first appeared in computer science literature in the 1960s, it was not until the late 1990s that the field began to emerge and separate itself from the statistics and computer science disciplines as analysts began dealing with much larger data sets and requiring quicker decision making processes. It became necessary to forego the theoretical statistics of the past and implement computer science techniques to begin coding algorithms to manage, analyze, and predict with big data. Data science was first introduced as an independent discipline in 2001, and has since had countless articles, reports, and papers advancing the discipline (Booze, 2013). It has even been declared in the *Harvard Business Review* as the “sexiest” job of the 21st century (Davenport & Patil, 2012).

While statistical analysis and data analytics are often used interchangeably, data analytics extends the focus to the analysis of larger data sets gathered from a wide variety of data sources (Davenport, 2013). In expanding the scope of traditional statistics, most in the industry now consider machine learning and data mining as important aspects of data analytics. It therefore follows from the definition of data analytics that 'business analytics' is actually data analytics, but applied within a business context. Closely related to the application of data analytics is the field of data

science, which many say has been newly defined to apply data analytics skills to further address emerging issues such as dealing with big data (Aasheim, et al., 2015).

The field of data science has been defined as a set of fundamental principles that support and guide the principled extraction of information and knowledge from data (Provost & Fawcett, 2013). It takes a multidisciplinary approach to the big data problem: not only is the data scientist skilled in data analytics, but should also be able to develop and test analytical algorithms, systems and applications through coding and programming at a high level (Dumbill et al., 2013). Additionally, a true data scientist would be expected to have excellent business skills to be able to judge the value of outcomes generated from analysis and to ensure that applications address intended business problems (Provost and Fawcett, 2013).

Though there may be subtle and debatable differences between the concepts of data science and data analytics, for the purposes of this study, the terms may be used interchangeably, depending on the source. After careful analysis of industry needs, curriculum guidelines, and the resources and goals of Delaware Technical Community College, there can be a final decision as to the title of the new program at the time of implementation.

Problem Statement

Previous studies (Aasheim, Williams, Rutner, & Gardiner, 2015; Hardin et al., 2015) have shown that very few colleges and universities across the U.S. offer data science and analytics programs at varied academic levels. Additionally, research indicates that by 2018, the U.S. alone will face a shortage of 140,000 to 190,000 professionals with the necessary analytical skills to make effective decisions (Zhao & Zhao, 2016). Currently, Delaware Technical Community College does not offer any

programs in data science or analytics. It is the purpose of this Educational Leadership Portfolio (ELP) to research the industry needs for entry-level positions in the fields of data analytics, both nationally and specific to the regions served by Delaware Tech, to conduct program evaluations on comparable programs, and to develop a new program proposal following the guidelines and standards set forth by Delaware Technical Community College.

In a joint study conducted by the American Statistical Association and the Society for Human Resource Management (SHRM, 2016), researchers aimed to cover the supply and demand of workforce development in the data analytics field while identifying key skills necessary to meet industry needs. Their findings show that 82% of organizations currently have positions in the data science field, with 59% indicating that they expect the number of required positions to grow over the next five years. The most common fields for these positions are accounting and finance (71%), human resources (54%) and business administration (50%), with 60% of organizations across all sectors requiring senior management to have data analysis skills. As this is certainly a positive indicator for the field as a whole, researchers from SHRM also found that within the last year, more than 78% of organizations reported difficulty in effectively recruiting for these critical data analytics positions.

A 2011 report by the McKinsey Global Institute noted that the data industry is growing at a rate of 40% each year and predicts that by 2018, the United States will face a talent gap of 50-60% relative to supply, as well as a deficit of 1.5 million managers and analysts who can effectively analyze data for purposes of decision making (Cárdenas-Navia & Fitzgerald, 2015). Davenport and Patil (2012) similarly suggest that there is scarcity of people with the unique skill set (math, statistics,

probability, programming, and business skills) to deal with data. As such, institutions of higher education, including community colleges, must be at the forefront in preparing students to meet these industry needs. In 2014, The American Association of Community Colleges (AACC) published their implementation guide to improve and empower the nation's community colleges. In *Empowering Community Colleges to Build the Nation's Future*, they recommend that to close the skills gap, community colleges will need to build capacity for identifying unfilled labor market needs and ensure that career education and training programs are targeted to address those high-need areas. One way to do this is building local, regional, and national partnerships (involving community colleges, employers, and government agencies) to accomplish a collaborative agenda that includes targeting skills gaps, promoting the associate degree as a desired employment credential, and establishing alternative models for completing skills-based credentials (AACC, 2014). The primary goal of this study is to research the most effective and efficient ways to move Delaware Technical Community College in this direction within the context of a new data analytics degree program.

While there is extensive research to highlight the need for qualified data scientists at the national level, there is also research to show a similar need in the local regions served by Delaware Technical Community College. In the most recent state of Delaware labor market demand report released by the Education Advisory Board, it was found that data scientists and business analysts are experiencing high demand with emerging employers, and data science skills make up four of the top five “fastest growing skills” that employers are looking for. Similar trends were also found for the surrounding states of Pennsylvania, Maryland, and New Jersey (Education Advisory

Board, 2015). Additionally, a similar 2015 study conducted by Burning Glass Labor found over 3,000 online job postings in 13 counties in and around Delaware that were advertising for data science and business analytics positions (CIRWA, 2015). But considering the speed at which the field is growing, it is likely that these numbers already underestimate the current need.

The continuous improvement of technologies and techniques in data science are transforming organizations into data intensive enterprises, but despite the resulting demand for experienced and knowledgeable graduates in the field, undergraduate education has been slow to respond. Currently, most data science instruction found at four-year higher education institutions is still housed within schools of engineering or computer science, largely limiting these crucial skills and opportunities to STEM graduates (Cárdenas-Navia & Fitzgerald, 2015). It is clear that colleges and universities should begin developing degree programs that will produce qualified graduates who can apply a variety of tools and techniques to manage and identify patterns in unstructured data while applying analytics to gain business insights that lead to improved decision making. Although academia is working to develop relevant programs, the supply of appropriately skilled graduates still lags behind the demand (Dumbill, Liddy, Stanton, Mueller, & Farnham, 2013). Given that data science and analytics is a multi-disciplinary field, workers will require a variety of talents, knowledge and skills. Because of this, a variety of degree programs will be needed at all levels of education, not just at the graduate levels (Aasheim et al., 2015).

The current state of supply and demand in the data science field presents an excellent opportunity for Delaware Technical Community College. While there is clearly a need for qualified graduates capable of filling various needs in the industry,

there is a shortage of academic institutions locally available to train these students. According to the Delaware Economic Development Office, more than half of all U.S. public companies are incorporated in Delaware, including 60% of all Fortune 500 companies. This includes prosperous industries ranging from aviation and agriculture to financial services and chemical manufacturing (Delaware Economic Development Office, 2017). So, as one of the primary missions of Delaware Technical Community College is create beneficial partnerships with local industry to produce a more qualified workforce, there should be plenty of opportunities to contribute to the solution of this problem within a new data analytics degree program.

One of the primary challenges of this project is to consider the perceptions of the same industries that Delaware Technical Community College serves and with which it strives to develop partnerships. Recent studies have demonstrated that the majority of job postings for data science positions, both locally and nationally, currently stipulate either bachelors or masters degrees as minimum requirements (Cegielski & Jones-Farmer, 2016; CIRWA, 2015; SHRM, 2016). While this initially appears that it could be a roadblock for the effectiveness of this proposed program, additional information in these postings instead offers strong support of this proposal. It is the position of this study that the human resource specialists charged with composing these job postings select minimum degree requirements as an arbitrary default and may not be fully informed as to what degree level is realistically needed to achieve the desired skills and abilities. Because data science is an emerging field, human resources professionals may not be acquainted with the nuances of data analytics training and qualification, so defaulting instead to a minimum degree requirement in the recruitment process is a possibility. The vast majority of these posts

also list the required and desired skills, which may not directly correlate with or justify the minimum degree requirements. In a recent 2017 report, the Business Higher Education Forum noted that when it comes to the field of data science, the practice of treating degrees as proxies for skill sets is no longer effective, as hiring managers may not be fully aware of the common nomenclature to converse in data science competencies and skills (BHEF, 2017). One goal of this project was to determine, through research and executive interviews with local industry professionals, how these degree requirements are considered, and what priority and weight is placed on demonstrable skills versus degree level.

Various research studies show that these primary skill requirements are knowledge of Excel, SQL, SAS, R, Python, SPSS, data mining and visualization, and predictive analysis (Cegielski & Jones-Farmer, 2016; Dumbill et al., 2013; Zhao & Zhao, 2016). One of the goals of this project is to propose a degree or certificate program in which all of these skills could be sufficiently mastered within the proposed two-year project-based curriculum. So, it will be helpful to communicate with local industry to determine what requirements, experience, and skills are necessary for graduates with associate degrees in data science to secure gainful employment. Consider, for example, a local financial institution recruiting for an entry-level data scientist with proficiency in SQL, SAS, R, and regression modeling. While the job posting currently includes a minimum degree requirement of bachelor's or master's degree, this institution may consider changing that requirement if it were confident that graduates from the new A.S. degree in data science from DTCC demonstrated mastery of the desired skills. As Hal Varian pointed out in his 2008 speech, the talent to analyze data and tell its story is scarce. Delaware Technical Community College

can provide those skills in the context of a two-year associate degree in data science, thereby providing a much needed service to its students and the region.

Organizational Context

Community colleges are a growing and increasingly important component of the higher education system and have been the platform from which millions of low and middle-income Americans have launched their careers and dreams. However, this American dream is at risk. As described in the 2012 report by the American Association of Community College, median income in the United States stagnated between 1972 and 2000, and has since declined by 7%. In today's society, a child born poor in the United States is more likely to remain poor than at any time in our history. But as a highly educated population is fundamental to economic growth and a vibrant democracy, community colleges can help students reclaim that dream. At their best, they provide America with a capacity that few other advanced industrial economies enjoy: the ability to rebuild the workforce, reinforce connections between education and the economy, and reverse the decline of the middle class through meaningful education, experiences, and employment. But meeting this challenge will require dramatic redesign of community college programs, their mission, and their students' educational experiences within many disciplines, including data analytics.

Delaware Technical Community College is an open-admission, two-year institution that grants diplomas, workforce development certificates, and associate degrees. It is the only community college in the state of Delaware and currently has four campuses across the state in Wilmington, Stanton, Dover, and Georgetown (Delaware Technical Community College, 2016a). As of 2016, the college's total enrollment included 13,471 students, 4,740 of whom were full-time. The college

population is 60% female, and 40% male, with approximately 56% of students reporting as Caucasian, 24% as Black or African-American, 10% as Hispanic or Latino, 3% as Asian, and 7% reporting as “other” or not indicating. The average student age is 25 years old, while the full-time student population has an average age of 22. For the class of 2016, DTCC awarded 1,698 associate degrees, 258 certificates, and 92 diplomas (Delaware Technical Community College, 2017).

The mission of DTCC is to offer comprehensive educational opportunities that contribute to the economic vitality of the state of Delaware. The institution aims to do this by preparing students with knowledge and skills needed for employment in a competitive workforce across a range of occupational levels (Delaware Technical Community College, 2016b). The Strategic Directions of the College provide focus for the institutional goals, which are in turn are relevant to the purpose of this Educational Leadership Portfolio (ELP). Among these Strategic Directions is the goal of strengthening and developing programs that demonstrate a strong student-centered focus, expanding and leveraging financial, operational, and partnership resources to meet increased workforce demand, and providing innovative programming that prepares competitive graduates for Delaware’s business and industry (Delaware Technical Community College, 2016c). The design and implementation of a data science program of study embodies this mission because it expands the opportunity of DTCC students within the workforce and simultaneously contributes to Delaware’s economic vitality.

Additional research and efforts will be needed to improve statistics and data science instruction at the two-year college level, raise the profile of statistics majors at these institutions, and facilitate articulation agreements for transfer to four-year

institutions (ASA, 2014). The number of students studying introductory statistics courses at community colleges has increased to more than 137,000 per year. This reflects the belief that statistics is a universal discipline, not just needed for a handful of students at the graduate levels, but required for a number of disciplines and recommended for many others. The American Statistical Association recommends that both industry and universities alike should streamline articulation agreements with community colleges and to support faculty development and curricular development at two-year colleges to meet this increasing need.

During a recent joint committee meeting between the American Association of Two-Year Colleges and the American Statistical Association, a project was proposed to address the feasibility of a data analytics curriculum for community colleges. The questions raised were concerned with the marketability of a two year associate data analytics degree, the resources needed to support these new programs, and the prior arrangements with four year schools and/or local industry (AMATYC, 2015). While the results of this research are still pending, this joint project illustrates that the development of data analytics programs at community colleges is a pressing professional consideration by the relevant national organizations, and illustrates how Delaware Technical Community College has an exciting opportunity to be one of the pioneering institutions to meet this challenge.

As DTCC strives to prepare graduates for an ever-changing job market using the lens of the Strategic Directions, many of the highlighted trends and recommendations underscore the work of this ELP and specifically the development of a new data science program. Specifically, the College notes that workers will require higher level math skills and more creative mathematical thinking to help

companies compete in a global economy, while also meeting the increased demand of professionals with technology skills (Delaware Technical Community College, 2016c). Given these considerations, one of the objectives of a new data analytics program is to fully consider these Strategic Directions and goals of the College when developing industry partnerships, rigorous curriculum designs, and authentic assessments.

Organizational Role

As an instructor, content expert, and instructional designer at Delaware Technical Community College, I am in a unique position to lead, inform, and support the development of a new data analytics degree program, which could bring about positive change to the organization as a whole. And while a project of this size and scope requires the coordination and cooperation of many different departments and stakeholders, my roles within the college have prepared me to offer insight on how many of the final components can be orchestrated to create a successful program.

The initial idea for this project, and the development of a data analytics program at Delaware Tech, began in the Fall of 2015. At this time, my role at the college was that of a full-time faculty member in the Mathematics Department at the Wilmington Campus. In addition to the regular course load duties of a mathematics instructor, I was also the “course leader” for Statistics I and II. Within the DTCC mathematics department, a course leader is responsible for determining the content of the course, creating or revising the syllabi, selecting course resources, and developing fair and effective assessment strategies. So, for my first few years as an instructor, much of my time was spent researching best practices in statistics education to be

adapted and implemented at the community college level with the goal of improving overall student success at DTCC.

While students enrolled in my Stat I and II courses come from different backgrounds and have different majors, all students learn many real-world statistical techniques using authentic data. This includes introductory data analysis, probability, hypothesis testing, regression, analysis of variance, and modeling. The content and concepts found in these courses are also required for many aspects within a data analytics program. According to the *Curriculum Guidelines for Undergraduate Programs in Data Analytics*, key competencies for an undergraduate data analytics major include linear modeling, probabilistic thinking, estimation and testing, and graphical data analysis methods (De Veaux et al., 2017). As there are certainly other required competencies for a data analytics program, including computer science, machine learning, and databases, my content knowledge of mathematics and statistics will be useful in developing effective course sequences for a new program in data analytics.

In January 2017, I accepted a new position at the college as an instructional designer with the Center for Creative Instruction and Technology (CCIT). While the role of an instructional designer can vary depending on the institution, my primary roles are to assist faculty with implementing best practices in teaching, develop and evaluate distance education offerings, and work with academic departments as they redesign their curriculum. I believe that my experiences with all of these will help better prepare me to work with faculty as we develop new course sequences, assessments, and teaching strategies. In order to design and develop this new data analytics program, there will be many questions and challenges that an instructional

designer will be equipped to handle. These include communicating with various departments, developing individual courses to support the program as a whole, helping faculty to create authentic assessments, and determining how distance education technologies will be utilized for various courses.

Improvement Goal

While the overall goal of this research was to ultimately design and develop this new degree program at Delaware Technical Community College, the intention of this proposal is to carry out the groundwork necessary to explore what such a degree program would look like, how it would interact with existing departments and stakeholders, and what type of industry partnerships could be established if the program were implemented at DTCC. To achieve this, the study was conducted with two primary improvement goals in mind. The first goal was to conduct and present research that not only supports the feasibility of a new associate degree in data analytics, but that would also help inform the realistic development and management of such a program from the ground up. The second goal was to create an informed framework and roadmap to develop this program specifically at Delaware Technical Community College. This was done following the specific guidelines, policies, templates, and procedures set forth by DTCC to produce an authentic and comprehensive proposal. This will help ensure effective and efficient reproducibility for the eventual development of the data analytics program at Delaware Tech.

Action Steps Towards Improvement

As previously discussed, there is a local, regional and national demand for qualified graduates with data science skills, and Delaware Technical Community College could satisfy a unique portion of that need through the development of an associate level degree program. While there will always exist an argument that data scientists need to have graduate level degrees, the thesis of the feasibility portion of this ELP research is that by following guidelines set out by the industry, successful graduates of this proposed program will be able to obtain gainful employment in a variety of industries, or be in an excellent position to continue their data analytics education at a four-year institution. The action steps completed for this study are shown in Table 1.

Table 1 Educational Leadership Portfolio Action Steps

Part I – Feasibility Study
<ul style="list-style-type: none">• Conduct research on the current state of professional data science and analytics.• Collect and analyze data analytics industry needs at the national and local levels.• Conduct executive interviews with local industry to determine desired skills and degree attainment; Obtain feedback on possibility of changing degree requirements of current/future job postings.• Research other data analytics educational options in the area served by Delaware Technical Community College.• Examine current mission and structure of Delaware Technical Community college to determine how proposed program may fit most efficiently and effectively.

Part II – Curriculum Development

- Research existing academic programs (including undergraduate and graduate levels) in data analytics.
- Conduct program evaluation of A.A.S. data analytics program at Wake Tech Community College.
- Conduct curriculum development sessions with college and industry representatives to identify the skills, knowledge, and attributes that the workforce requires of graduates.
- Articulate high level program outcomes and develop curriculum using backward design principles.
- Write course descriptions for new and existing courses within the proposed program.
- Create official program course sequence sheet.

Part III – DTCC Program Proposal

- Curriculum and course program sheet submitted to industry representatives and potential partners for feedback.
- Write A.S. Data analytics white paper to support case for offering new degree.
- Compile and present findings as new program proposal following Delaware Technical Community College requirements.

Part IV – Program Review Analysis

- Develop a five-year program review assessment plan of the DTCC Data Analytics Associate Degree Program to ensure that the mission and strategic directions of the college are being met by the program.
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Chapter 3

IMPROVEMENT STRATEGIES AND OUTCOMES

Introduction

When the first data analytics exploratory committee was formed at Delaware Technical Community College during the Spring of 2015, there were a number of legitimate questions and concerns raised about the feasibility of developing a new associate degree program in data analytics. As this committee was comprised of faculty, chairs, and administrators from a variety of backgrounds and disciplines, the initial problem that emerged was simply the ability to discuss data science, analytics, and informatics in a common language. This is understandable as data science is still an emerging and developing field that can be utilized in very different ways depending on the industry. Another major concern was whether or not such a program would support, and be supported by, the local labor market and industry partners. The mission of preparing and connecting local Delawareans with gainful employment opportunities through community and industry relationships is a driving force for all decisions and initiatives related to curriculum. Finally, there was apprehension to move forward with this project once it was realized that there were no other community colleges in the United States offering an associate degree in data science or analytics at that time. It was decided that these concerns alone were enough to put the project on hold and disband the data science working committee. However, while these issues were certainly legitimate, I felt the need to research this topic further, both for my Educational Leadership Portfolio, and to support innovation and improvement at Delaware Technical Community College through the possible advancement of this new degree proposal.

Occupational Analysis / Feasibility Study

In the past, Delaware Technical Community College has relied on an internal department, The Center for Industry Research & Workforce Alignment (CIRWA), to conduct industry guided research. Their mission is to analyze labor market data to improve college wide programming and recommend proactive and strategic decisions in economic and educational development (CIRWA, 2015). This research is usually the college's first step in determining the feasibility of new academic programs. According to the college's Program Development Process, the first step is to investigate evidence of labor market need for the proposed program including its relationship to state economic development, available jobs, and salaries. This may be accomplished through a labor market survey, content analysis of labor market information, or by conducting interviews (Delaware Technical Community College, 2017). One of the initial challenges faced by the DTCC data science working committee is that CIRWA was not available to conduct the necessary research or produce an occupational analysis report. Unfortunately, it was determined by the group that without this study, the proposal of a new data analytics program could not move forward. In an effort to contribute to this project, I offered to conduct an occupational analysis using some of the same strategies and guidelines as CIRWA. The specific details, data, and resulting research, is included in this Educational Leadership Portfolio as Appendix B.

The purpose of the occupational analysis was to research the industry needs for entry-level positions in the fields of data analytics, both nationally and specific to the regions served by Delaware Technical Community College (DTCC), to provide analysis and recommendations to better inform a new program proposal for a new A.A.S. degree in data analytics.

The research objectives were to:

- Explore national employment trends in data analytics
- Estimate regional data analytics employment and projected growth
- Identify employer demand and preferred level of education for selected data analytics skills sets
- Assess hiring challenges for data analytics positions
- Determine regional employer needs

This was accomplished through a mixed-methods analysis using research, content analysis, surveys, and interviews. The primary collection of data took place between October 2016 and August 2017. The report also includes secondary data from a variety of sources including the Bureau of Labor Statistics, Burning Glass, and LinkedIn.

Job Posting Skills Audit

The initial step was to search through the required skills desired by employers in current job postings found on popular job websites. These findings further developed research questions and provided valuable information to conduct a feasibility study for the creation of data analytics programs at the community college level by exploring the question: ‘What technical knowledge and skills should be taught in a two-year program to prepare students for entry-level careers in data analytics’?

Research Design

This study explored the current climate of the data analytics industry through active job postings. The design of this research was primarily content analysis. This

method is a technique that allows researchers to study different components of human interaction through written communications and has many applications in educational research. It requires examination of language for the purpose of classifying text into categories with specific meanings. This is typically accomplished through the establishment of a coding schema that is used to classify and organize the content of interest prior to analysis (Fraenkel, Wallen, & Hyun, 2012). Additionally, this research design can be used to provide critical information to further develop a hypothesis, which can then be explored using more direct methods. In the case of this study, a content analytic approach was used to examine active job postings for entry-level data science and business analytics positions. Through this analysis, the goal was to determine trends in required skills and abilities that employers are looking for in potential candidates.

A purposive sample was used for this study. To address the specific research question, entry-level job listings posted on four of the most used professional networking and employment sites (Indeed, GlassDoor, Career-BUILDER, and Monster) were selected for audit. These sites were selected as content sources because they each have a significant number of data analytics postings, as well as search options that could help to identify required skills of entry-level positions. Initial searches for jobs using the titles “data science” and “data analytics” yielded over 10,000 such active positions. Additional filters were used to limit the results to positions that are full-time, require fewer than 3 years of experience, and are within the local regions of Delaware, Pennsylvania, Maryland, and New Jersey. It is worth noting that these

filters were put in place to support the specific research question of this study, ‘What technical knowledge, skills, and abilities should be taught in a two-year program to prepare students for entry-level careers in data science within the greater Delaware region’? There are certainly other desired skills prevalent in the fields of data science and business analytics, especially at the upper levels, but this study aims to identify the baseline knowledge and skills that can be mastered within the scope of a two-year program.

Results

A total of 58 active job postings were identified as suitable for this study. This indicates that they have been verified through the specific company website, and list required skills. All of these postings are for positions in Delaware, and were identified using the search terms of “data analyst” or “data scientist”. Based on these preliminary results, it is clear that specific trends exist as to what skills are required for data analyst positions. Over 87% of postings listed SQL as a required skill, 65% listed, SAS, and 53% indicated Excel as a desired skill for employment. These findings will help inform what coursework should be included in the proposed program.

Recommended Use of Findings for Problem Solving

A key to success for any data analytics program is to integrate the concept of “learning by doing”. Analytics with big data requires real-world experience and insights that can only be generated by repeatedly addressing the issues in many

different ways (ASA, 2014). Strong relationships and partnerships between academic programs and industry partners can strengthen the experiential learning aspect of the educational program. It is for this reason that it is important to stay informed of what the industry needs from future analysts. Data from this study will allow data science program leaders to communicate with industry and develop relevant project-based coursework.

Within the college itself, an important step in developing a quality program is specifying program level learning outcomes. These should be clear goals and skills that can be translated into specific, observable, measurable behaviors that can provide evidence of student learning and growth within the program (Delaware Technical Community College, 2017). The data and trends found in this study can help the program and curriculum development committee at Delaware Technical Community College to develop more sound components that focus on the technical skills that will be most beneficial to graduates. Specifically, while this study was small in scope and encountered limiting factors, it is still evident that the skills of SQL, SAS, and Excel appear to be relevant and in demand with local industry looking to hire people with data analytics skills. Additionally, even if all of the relevant technical skills are not able to be included in the associate degree program, the results of this study can hopefully serve as guidelines for future studies for students who wish to pursue a career in data analytics.

Regional Professional Survey and Interviews

Research Design

In order to gather more data concerning the skills and labor market, an additional study was designed in order to illicit information through both survey and interviews with professionals working in the field of data science and analytics. The survey and interview protocol is provided as Appendix C. This mixed-method study provided both quantitative and qualitative data regarding the current labor market needs and skills. The industry based social network LinkedIn was used to identify potential participants for this research. This site was used because of its popularity among professionals in many sectors, as well as the advanced filtering features that can be used in identifying people within the data analytics industry.

The first criteria in selecting a potential sample group was to identify professionals from some of the larger employers in the region served by Delaware Technical Community College. These companies were intentionally selected across a variety of industry sectors and an additional filter was applied to only return results of those who worked within 50 miles of Newark, Delaware. This was to ensure that the sample was representative of the local industry.

The other criteria for sample selection was the addition of a keyword filter. By adding the keywords of “data science”, “data analytics”, and “business analytics”, search results were limited to professionals who had these job titles or skills listed in their profiles. Of the returned results, 40 professionals were selected to be invited to

participate in both an informational survey and/or phone interview. While there were more people who satisfied the sample criteria, the number contacted was limited to 40 by the restrictions of the membership offered by LinkedIn. In order to increase the probability of increased responses, a purposive sample was utilized to select professionals with recent LinkedIn activity and complete profiles as preference. Each person was sent an email message through the LinkedIn site to participate in the survey and/or interview. Of the 40 professionals contacted, eight fully completed the survey and three agreed to participate in interviews. Information for these participants is provided in Appendix B.

Labor Market Assessment Results

In order to develop a general sense of the data analytics field in the local area, participants were asked about hiring and demand specific to their organization. A majority of respondents were confident that the demand for data analytics workers would increase over the next five years, with 50.0% anticipating the need to significantly increase, and 37.5% expecting a slight increase. Similarly, 75.0% of surveyed professionals anticipated that their organization would more than likely be investing in data analytics initiatives during this time. The remaining 25.0% responded as unsure, while no one indicated that they expected no investments at all. And while there is a common feeling that the need for workers skilled in data analytics will rise to meet the needs of industry, 75% indicated that it has been “challenging” for their organization to recruit for or fill positions requiring data science skills, with an

additional 12.5% indicating that it has been “very challenging”. Only 12.5% indicated that their organization has not had a significant challenge recruiting for these positions. As none of the respondents were in positions that had direct interaction with the collection of applications and resumes, all were unsure about of the proportion of applications that were being submitted by job seekers from outside of the Delaware region.

Skills Need Assessment Results

In order to identify the relevant skills and technologies that are being utilized by data analysts across local industry, respondents were asked to describe how often they rely on and utilize specific technologies in their work. Also, to obtain further information on what technologies and skills should be considered for academic programs in data analytics, participants were also asked to rank the importance of each technology to an undergraduate academic program. The highlights of these results indicate that 87.5% of respondents are using both SQL and MS Excel frequently and more than 50% are utilizing R and SAS on a frequent basis. Not surprisingly, the majority feel that these skills are also important to be included in an undergraduate data science curriculum. One surprising result was that while only 12.5% of respondents use Python on a frequent basis, 71.4% indicated it as a “very important” technical skill to be covered in an academic program. This may indicate that while many organizations are not currently conducting data analysis using Python, it could be a technology that is on the rise within the industry. This research was also useful in

identifying several technical skills which may not be critical to entry level data scientists at this time. The vast majority of respondents stated that not only do they rarely use applications such as SPSS, JMP, Hive, and NoSQL, but they also do not think these technologies would be important to include in an undergraduate curriculum. The full results of these survey questions are shown in Tables 9-10 in Appendix B.

In order to explore the feasibility of offering a data analytics degree at the associate level as opposed to the traditional bachelor's or graduate degree, participants were asked if they would consider hiring someone who recently completed an associate degree in data analytics. Of these responses, 12.5% stated that they would absolutely consider hiring someone with an A.A.S. degree, while the remaining professionals (87.5%) replied that they would consider such a graduate, depending on their work history and/or completed coursework. Importantly, no one indicated that they would refuse to consider a graduate who only had an associate level degree in data analytics.

Interviews

In addition to the survey responses, interviews were conducted with three individuals working as data scientists and analysts in the local region. Similar to surveys, interviews are an indirect measure used to obtain qualitative data where respondents are reflecting on knowledge or learning, rather than demonstrating it (Stassen, Doherty, & Poe, 2001). Each interview was conducted as a semi-structured

interview. With this method, the same questions are asked of all respondents, but the interview is more conversational and the interviewer has the freedom to rearrange or rephrase the questions (Ary, Jacobs, & Sorensen, 2010). The interviews were conducted between August 1, 2017 and August 15, 2017. The interviewees ($n=3$) represented various key administrative, operational, and technical levels in their respective organization. Interviews lasted between 30 minutes and 45 minutes and were conducted via face-to-face and phone. Interviews focused on issues such as current and projected hiring needs for data scientists and labor market needs and challenges. A complete list of study contributors, as well as supporting interview quotes can be found in Appendix B. Through these interviews, there were several key items of relevance to be considered for the development of a data analytics program.

- **Though it is not necessarily required, few organizations currently staff data analysts with less than a bachelor's degree.** However, while this has been current practice in the past, organizations may not be opposed to hiring individuals with an associate degree if they can demonstrate proven technical abilities. In fact, it appears that many organizations are hiring people with data analytics skill who have bachelor's degrees in unrelated fields, but who have been successful through self-education and experience.
- **Although technical skills are important, employers are emphasizing the need for skills in communication and business.** If an applicant has less than a bachelor's degree in data analytics, they are much more likely to be hired if they

possess strong interpersonal skills, such as communication, teamwork, leadership, and motivation.

- **While there is no consensus on everything that needs to be included in a data analytics curriculum, there are reliable skills and tools to include.** As data analytics is still such a new and emerging field, and various industries are using it in different contexts to meet their needs, it is not always clear as to what skills are critical. However, by exploring what is being used most often and what lends itself to industry convention, trends can be observed to help develop a more informed curriculum.

Key Findings and Recommendations

The recommendations below are listed so as to correspond to the research described above and can be generalized into two broad objectives; closing the gap in the projected industry demand and developing a quality and efficient educational programs to satisfy employer needs.

Recommendations 1 and 2 aim to help Delaware Technical Community College to increase enrollment in the data analytics program examined in this study and raise awareness of the educational and career pipeline opportunities available in this field. Recommendations 3 through 6 seek to help DTCC develop quality data analytics programming so as to better meet the skill needs of local employers while

ensuring that graduates are entering the workforce ready and able to succeed in today's competitive job market.

1. Organizations have high growth expectations for data analytics within the next five years. This presents a unique opportunity for Delaware Tech to develop a program that will satisfy the needs of local industry while following the Strategic Goals of the college. Evidence of this growth should continue to be researched and documented by the college to help market this new program to potential students while also selling the effectiveness of the program to local industry.
2. Work toward developing articulation agreements and certificate options. In order to increase potential student enrollment, it will be beneficial to offer additional pathways. By offering certificate options, DTCC can recruit working professionals who may already have a degree, but are interested in advancing their career through improved knowledge and skills. Additionally, many students may want to eventually continue on to a bachelor's degree in data analytics, so offering a pathway for transfer could increase enrollment while allowing students to also pursue high-order skills to satisfy industry need. This pathway is seen in many other programs at Delaware Tech where students would prefer to start their undergraduate degree at a more affordable option such as a community college.

3. Focus credit coursework on a well balanced mix of mathematics, business, and data science. Explore having students learn the field by working with established and practical technologies such as R, Python, and Excel. Also, faculty should be encouraged to include project-based learning often throughout the program so students are comfortable applying authentic aspects of data analytics. It is recommended that the college research the feasibility and efficiency of utilizing other technologies that may require licensing fees.
4. Focus on professional and career navigation skills, with an emphasis on communication, collaboration, and problem solving. Professionals in the data science field commented on the importance and shortage of these skills, specifically in the context of what data scientists are often required to do on a regular basis. This new program could benefit from an enhanced curriculum focused on long-term career skills such as teamwork, communications, analytical problem solving, etc. This can be accomplished through exercises or group projects that focus on developing a student's professionalism, confidence, and business skills. Additionally, the college should provide a well-rounded core curriculum including relevant courses in English, communications, ethics, and business. This will help enable program graduates to better facilitate professional relationships and strengthen business opportunities for their employer.

5. Incorporate capstone and/or internship models in the program. As data analytics is an applied discipline, it is critical that graduates enter the workforce with the ability to prove their capabilities. Being able to demonstrate their mastery of skills through a professional and authentic capstone project and portfolio will be the critical component of allowing employers to look past the idea of requiring a bachelor's degree to consider a well-qualified graduate of this associate degree program in data analytics. This requires leveraging and expanding relationships with participating local industry, many of whom were identified in the research.
6. Finally, this study only generalizes the labor market for select organizations, across specific skills sets. It may be beneficial to further examine labor market information in more detail at the skill and organizational levels as a follow up to this report. This could be accomplished through open dialogue and the sharing of information with other relevant academic institutions with similar goals in the data analytics field. Also, occupations represented by the various skill sets could be tracked over time to monitor for changing requirements regarding education and experience, as well as the changing needs of specific employers.

Conclusion

Through a variety of measures, it is evident that data analytics is a high-growth field both at the national and regional levels. While these fields traditionally tend to favor individuals with graduate or bachelor level degrees, it is becoming more likely that there will be significant opportunities for those who may have less than a bachelor's degree. Graduates who have completed a well-rounded associate degree, earned industry certifications, and have collaborated on an authentic capstone project should be able to demonstrate the necessary knowledge, skills, and abilities to be successful in a variety of positions within data analytics. Delaware Technical Community College has the chance to provide this opportunity to motivated Delawareans looking to enter the emerging and exciting field of data analytics.

Case Study of Wake Tech Community College

Another important component of this work was the examination of data analytics programs at peer institutions. At the time of this ELP, there was only one existing associate level degree program in data analytics. Wake Tech Community College, located in North Carolina, began offering an associate degree in data analytics in the Fall of 2013. The program is fully accredited and qualifies students for employment as data scientists and analysts in the fields of finance, logistics, healthcare, manufacturing, information technology, and government (Wake Tech Community College, 2017). This program was evaluated to determine if any best practices can be effective for the development of a new program at Delaware

Technical Community College. While a cohesive summary of this study follows, the specific research details and full report can be found in Appendix D.

Introduction

Wake Technical Community College (WTCC) is a two-year public community college serving residents of Wake County, North Carolina, which is home to more than 900,000 residents. As the largest community college in North Carolina, it serves more than 71,000 students annually across five campuses. The institution offers more than 200 associate degrees, diplomas, and certificates to prepare students for employment or university transfer. Wake Tech also offers non-credit workforce training and business support, as well as basic skills (including high school equivalency preparation). Wake Tech's mission is to improve and enrich people's lives by meeting the lifelong education, training, and workforce development needs of the community.

In February 2012, Wake Tech proposed a new Associate Degree in Business Analytics (A.A.S.) program to the North Carolina Community College System and the Southern Association of Colleges and Schools. And although the courses had not yet been developed at this time, approval was granted from both organizations. It was in October 2012 that Wake Tech received grant funding from the Department of Labor (DOL), which allowed them to target key populations while accelerating the development of the new Business Analytics associates degree program (BAS). In developing this pioneering program, Wake Tech sought to prepare students for the anticipated in-demand analytics jobs of the future and was able to create the first data analytics associates degree in the United States.

The Business Analytics program provides credentials by offering students the options of preparing for two analytics certificates, gaining an AAS Degree in Business Analytics, and/or transferring to a four-year degree program in applied science, business, or statistics. The accelerated business analytics program option is available for persons with entry to mid-level skills and some college training who may want to quickly gain skills that lead to industry certificates and prepare them to sit for certification exams.

Purpose of Study

As the goal of this program proposal is to create a new Data Analytics Associate Degree at Delaware Technical Community College, it is important to look at the challenges and successes of other institutions who have gone through a similar process. In an attempt to meet industry needs, data analytics programs are on the rise at institutions of higher education across the country to close the growing skills gap. But the overwhelming majority of these programs are at the bachelors or graduate levels. So while offering such a new and cutting edge program at the community college level at this point presents an exciting and unique opportunity, there will also be challenges that are unique to developing and delivering such a program. For this reason, it is critical to examine not only other institutions who are now creating data analytics programs, but specifically at other community colleges. As mentioned previously, Wake Tech Community College is currently the only such institution and has only recently began offering their program. And while this may prove to be a limitation when it comes to finding data related to student and program outcomes, Wake Tech's experiences in rolling out their program from the ground up can prove valuable to the development of a similar program at Delaware Technical Community

College. It is also important to note that while the program at Wake Tech Community College is called “business analytics,” and the proposed program at Delaware Technical Community college is being referred to as “data analytics,” there will most likely be few differences between the program objectives and curriculum goals of the two programs. This is due primarily to preference, as well as the fact that there is still little consensus as to the specific variance in definitions of business analytics, data analytics, and data science.

Research Questions

The key program implementation and outcome questions of the study were:

1. How was the WTCC Business Analytics program designed, developed, and delivered since its original proposal?
2. To what extent has the program been effective in producing the desired student outcomes with regard to completion, placement, other?
3. What were the key challenges in the development and administration of the program and how has the program since addressed those challenges??

The research approach of this study is based on the major questions presented above. This case study documents the design, development, and implementation of the Business Analytics degree program at Wake Tech Community College. A mixed methods approach of data collection was utilized to ensure triangulation of results with a complete listing of consulted resources found in Appendix D.

Description of Program

The Wake Tech Business Analytics curriculum is designed to provide students with the knowledge and the skills necessary for employment and growth in analytical

professions. Business Analysts process and analyze essential information about business operations and also assimilate data for forecasting purposes. Throughout the curriculum, students engage with the latest tools and technology utilized in today's analytics fields and focus on developing new insights and understanding business performance using data and statistical methods. The WTCC Business Analytics Associate Degree requires 65 semester credits, including eight BAS courses and other electives in computer science, logistics, mathematics, English, business, and humanities. All courses are offered at WTCC. It includes two certificate programs that allow students to gain industry certification from SAS, either in Business Intelligence or Business Analytics. Additional information regarding the development of the program, faculty, curriculum, and student outcomes are presented in Appendix D.

DTCC Data Analytics White Paper

In order to begin the process for the proposal of a new academic program at Delaware Technical Community College, the idea needs to be submitted to the Campus Director or President's office. This can come from an academic department, working committee, or state agency. This can be presented as a white paper which provides a background of the program, how it can impact Delawareans, and how it fits within the context of Delaware Tech (Delaware Technical Community College, 2017). In accordance with this requirement, a white paper was drafted to address these questions (Appendix E). Along with providing a summary on the current state of data science and analytics, and research to illustrate the shortage in the labor market, the context of how this new program would align with the mission of Delaware Tech was also discussed.

From the beginning, the community college mission has been to provide open access and prepare graduates for entry-level positions in career fields that meet the community's needs. The specific mission of DTCC is to offer comprehensive educational opportunities that contribute to the economic vitality of the state of Delaware. The institution does this by preparing students with knowledge and skills needed for employment in a competitive workforce across a range of occupational levels. Among the Strategic Directions of the College is the strengthening and developing of programs that demonstrate a strong student-centered focus, expanding and leveraging financial, operational, and partnership resources to meet increased workforce demand, and providing innovative programming that prepares competitive graduates for Delaware's business and industry (Delaware Technical Community College, 2016b). Specifically, the College notes that workers will require higher level math skills and more creative mathematical thinking to help companies compete in a global economy, while also meeting the increased demand of professionals with technology skills (Delaware Technical Community College, 2016c). The design and implementation of a data analytics program of study embodies this mission because it expands the opportunity of DTCC students within the workforce and simultaneously contributes to Delaware's economic vitality.

DTCC Data Analytics Curriculum Proposal

The proposed associate degree program in data analytics will be designed to meet the growing workforce demand and to provide students with the skills necessary for gainful employment in analytical career fields. This program is interdisciplinary in nature and includes content from computer science, mathematics, and business. The curriculum will be hands-on and application based with authentic assessments

informed by partnerships with local and national industry. In order to ensure industry consistency and improve opportunities for articulation and transfer agreements, nationally recognized research and standards such as the Guidelines for Assessment and Instruction in Statistics Education (GAISE), and the American Association of Community Colleges (AACC) were consulted. These national standards for statistics and data science have been developed because traditional statistics curricula have not kept up with pressing demands for graduates who can make sense of data, and will therefore be used to inform program curriculum design for the new A.A.S. in data analytics at DTCC.

Course Sequence and Descriptions

In developing the course sequence sheet (Appendix F) for the proposed data analytics program, several sources of reference were considered. First, the case study of Wake Tech Community College's business analytics program (Appendix D) provided extensive guidance on what aspects of a data analytics curriculum could be achieved within the condensed structure of an associate degree program. Some key findings that were implemented were to:

- Keep course descriptions general. The objective of the program should be for graduates to master skills and concepts, not just specific technologies. This is especially true as there is a lack of industry consensus regarding common skills.
- Structure the program as open enrollment to not only increase enrollment, but to better align with the college mission by making it more accessible and with fewer perceived obstacles.

- Provide a well-rounded program that touches on a variety of data science concepts and tools, while also including relevant coursework from other disciplines.
- Encourage the development of skills related to collaboration, problem-solving, and business acumen.
- Offer a certificate option for working professionals who may already have an undergraduate degree but would like to work towards advancement through enhanced skills and education.

In addition to submitting a proposed course sequence sheet with a DTCC new program proposal, it is also required to submit course descriptions. The descriptions of the proposed new DAS course in data analytics were developed through examination of similar courses at other institutions, looking at what general skills are required from industry, and through communication with current faculty at Delaware Tech. In accordance with the recommendation from Wake Tech Community College, these have been intentionally kept very general to encourage input from faculty and subject matter experts during the final curriculum development process. Non-DAS courses in the program proposal are all courses that are already offered at DTCC with previously established course descriptions.

Specific Technology Skills

While there are advantages to keeping the course descriptions general to allow for flexibility in the curriculum development, there are specific skills and technologies that will need to be utilized to prepare graduates for the workforce. For this new DTCC program, it will be proposed that students work with the following technologies across the program to increase their skill set and marketability. While

these are only recommendations, these suggestions were supported and informed both by the occupational analysis study (Appendix B) and Wake Tech case study (Appendix D).

- Excel – Microsoft Excel should be used extensively in the Introduction to Analytics course as it is familiar to many students, can handle basic statistical analysis and visualization, and is in demand from industry.
- SQL – As the most popular database management software, this could be used in courses related to data programming and/or data structures.
- R – As R is a freeware tool, a considerable amount of industry, especially small business, still rely on this tool as their primary method of data analysis. This could be used in the course Applied Data Programming.
- Python – Python is an interpreted, object-oriented, high-level programming language with a shallow learning curve that is regarded as an in-demand skill for data scientists. Students could use this tool in the Introduction to Predictive Modeling course.
- Tableau – While other tools may be available for data visualization, some professionals in the field rely on Tableau on a regular basis. Students can benefit from using this program for Data Visualization.

Supplemental Coursework

In addition to the development of new data analytics courses, the proposal recommends incorporating a variety of established courses from other departments within DTCC. Courses in Business and Economics provided students with a sound background in the professional environment in which data scientists work as well as

the foundational theories of business. Through a sequence of English courses, students will be prepared to effectively communicate and present the results of the data analysis. The results of the occupational analysis indicate that these critical skills are often lacking prospective and new data science hires. In order to support the mathematical foundations of data science, Statistics and Analytical Mathematics are proposed to introduce students to necessary concepts of descriptive and inferential statistics, linear algebra, and hypothesis testing, among others.

It should be noted however, that these proposed courses and technologies are recommendations. There should be a more extensive development process with instructional designers, subject matter experts, and faculty to create more specific learning objectives within each course.

DTCC New Program Proposal

Following the procedure set forth by the Curriculum Guidelines, a new program proposal document was created. For consideration by the Advisory Committee, this is required to contain a need for the program, program mission, description and goals, as well as a proposed course listing (Delaware Technical Community College, 2017). This proposal (Appendix G) is a culmination of all research that was completed throughout the development and ELP process.

DTCC Program Review Assessment Plan

Program assessment focuses on assessing student learning to determine if students have mastered the skills, knowledge, and competencies associated with their program of study. The results from an assessment process should provide information that can be used to determine whether or not intended program outcomes are being

achieved, as well as how the program can be improved. A program review assessment should also be designed to inform faculty and other stakeholders about relevant issues that can impact the program and student learning (Stassen, Doherty, & Poe, 2001).

To work towards successful implementation of program assessment, Delaware Technical Community College has developed a Program Review Model. Program Review is conducted to ensure academic programs remain relevant to the College Mission, demonstrate alignment with Middle States' standards, and operate effectively and efficiently with adequate resources necessary for success. The spirit of Program Review is analytical and collaborative, while the purpose of Program Review is improvement. The purpose of this review is to provide an opportunity to analyze an academic offering's operation and effectiveness in comparison to the established standards and to plan improvements accordingly (Delaware Technical Community College, 2017). In accordance with this model, the review assessment is framed within a five-year cycle that assesses both operational standards and program goals.

Department chairpersons and faculty collect and analyze program data to determine the extent to which academic programs exhibit the standards described in the Program Review Plan. Assessment for program and student learning outcomes will be conducted in the context of continued improvement. The program should maintain evidence that the results of these outcomes are part of self-evaluation, planning, and improvement of the program. Examples of such evidence include development of leadership teams to ensure effective decision making. Meeting minutes and reports, in addition to the annual assessment report, may serve as evidence of engagement and use of data to support student achievement and overall improvement of the program.

Strategies should include improving access to resources and best practices, as well as strengthening innovation, growth, instructional, and assessment practices.

To achieve the goals of the DTCC Program Review, and to ensure that operational and program goals are being met within the program, a new Program Review Plan and Matrix has been developed for the proposed data analytics program (Appendix H).

Chapter 4

REFLECTIONS AND RECOMMENDATIONS

As I began this process, I was confident that I had a sufficient understanding of data science content as I have been teaching introductory and advanced statistics for many years. I was also confident in my abilities to develop curriculum as a professional instructional designer. But throughout this research, I realized that I still have much to learn in both aspects. And while I have gained valuable knowledge and experience in research, communication, and content, there are some areas of this program proposal that should be further examined if Delaware Technical Community College plans to move forward with an associate degree in data analytics.

Occupational Analysis

While the overall approach of my occupational analysis research proved to be effective in accomplishing the same research methods as the Delaware Tech CIRWA process, there were certainly issues and limitations that prevent the resulting data from being statistically significant or representative of the regional industry as a whole.

While conducting the job posting skills audit, the initial data collection process did yield some relevant information, but it also presented a variety of challenges and limitations to this search method. When conducting research that relies on non-random sampling such as this, it is critical to consider external validity, and the extent to which the sample represents the population as a whole (Fraenkel, Wallen, & Hyun, 2012). Because the job posting sites are considered to be four of the largest such sites, I was confident that this data collection method would be a fair representation of what skills local industry were requiring from applicants. However, while these popular job posting sites do provide filters to help narrow down searches to location, job title, and

relevant skills, there appears to be a consistent lack of integrity in the resulting job postings. For example, the majority of results are formatted to appear like authentic job postings, but are actually links to external and unrelated websites. Additionally, many postings are not generated from actual openings, but are auto-generated using popular keywords and linked to other job posting sites or to generic recruiting firms. In other words, these job posting sites have been overtaken with false posts which make it challenging to identify what information is authentic. From this experience, I now know to question results of research that rely primarily on data taken from job posting sites. This is especially true when it is a computer algorithm that is gathering data, as opposed to a person who can make the distinction between real and fake postings.

While the method of using surveys and interviews was an excellent opportunity to connect with professionals working in the field of data science, the ability to generalize data from the survey and interview data was limited to the quality of the sample frame. Specifically, this research utilized only the respondents ($n = 8$) from the LinkedIn search pool ($N = 40$) as previously described. This low sample size makes it difficult to construct a survey population that mirrors the region's data analyst composition at a significant level of confidence.

Based on these challenges and limitations, it is recommended to conduct additional research at the local level to establish a more informed skills profile and labor market, and careful consideration should be given before making statistical inferences based upon the findings and conclusions of this report. One way to achieve this would be to put in place the parameters permitting The Center for Industry

Workforce Alignment (CIRWA) to conduct a larger scale occupational analysis as they have done for other programs.

Case Study of Wake Tech Community College

Based on the information gained during the case study of Wake Tech Community College's (WTCC) Business Analytics program, there are a number of preliminary lessons that would certainly help inform the process of creating a new associates level degree program in analytics. While there will no doubt be additional challenges that are unique to Delaware Technical Community College, the following lessons from this study should be considered throughout the program proposal, design, development, and delivery:

- Recall that the goal of the program is to have students understand analytics, and not only analytics software tools. As data analytics is such a rapidly developing field with ever changing and improving technologies, it is important to continue refining the program to match the conceptual needs of industry.
- The institution should proactively form partnerships with industry leaders and other academic organizations through the formation of something similar to an advisory board. This will help keep the curriculum relevant and authentic, while also creating opportunities for articulation agreements and real-world analytics experiences through internships.
- Identify and actively recruit instructors with the right skill-set and attitude. This may prove to be challenging as professionals with the required skills are often working at salaries above what can be offered by community colleges. But if the faculty and staff are not experienced with the necessary concepts and

tools, as well as how they apply to professional situation, the program will not be successful in meeting its goals.

- The program needs to be willing to adapt based on student feedback and trends in the industry. While there will be extensive work done on curriculum and content design at the outset of the program, it is critical that this development does not stop there. There should be ongoing work done between program leaders, faculty, instructional designers, and industry representatives to ensure that the program remains relevant.
- Look for creative ways to provide additional funding opportunities to the program. This could be done through grants from various organizations and should be researched in coordination with DTCC administrators and members of the grant committee. This could help ensure the continuation of the program while also improving the chances of hiring exceptional faculty and staff.

The Curriculum Development Process

When proposing and creating a new academic program, the most challenging and time consuming aspect is developing curriculum. This includes everything from establishing program goals, learning objectives, assessment measures, technologies, and resources. For this Educational Leadership Project, my goal was to make informed recommendations as to what such a program could look like, but I certainly lacked in much of the knowledge necessary to develop a fully-fledged program. For example, as I am not a content expert in the field of data analytics, I can only think about course and program design in terms of what information I can gather from those who have done it before, or have specific content knowledge. So it is reasonable to suggest that if this project were to move forward at Delaware Technical Community College, a

more through and cohesive instructional design process should be used in developing the new curriculum.

A recommended approach to this would be to use a DACUM (Develop a Curriculum) process. This process is an innovative approach used for occupational, educational, and functional analysis. This is a collaborative process involving a panel of subject matter experts, industry representatives, and a neutral facilitator. It is founded on the idea that expert workers can define their job and skills more accurately than anyone else, and that as effective way to describe a curriculum is to describe the tasks that expert workers in the field perform. The specific process for this model is conducted over a two-day workshop that covers a needs analysis, task analysis, and curriculum development (Norton, 1998). By conducting industry analysis while involving highly skilled professionals, Delaware Technical Community college can ensure that the curriculum remains relevant to the current and future needs of the local industry.

Participation in National Initiatives

During the research for this ELP, there was an exciting and unanticipated development closely related to my study. As I was looking into the feasibility of offering an associate degree in data analytics, the American Statistical Association (ASA) and American Mathematical Association of Two-Year Colleges (AMATYC) were working jointly to also explore this same topic. In 2016, a grant proposal (Appendix I) was submitted to the National Science Foundation to convene a summit on two-year data science curricula and program development.

This grant was approved by the NSF on August 7, 2017 (Award #1735199). It is sponsored by the American Statistical Association and is led by the following investigators:

- Steve Pierson (Principal Investigator)
- Roxy Peck (Co-Principal Investigator)
- Robert Gould (Co-Principal Investigator)
- Mary Rudis (Co-Principal Investigator)

As stated in the project abstract, previous projects have considered potential undergraduate data science curricula and have proposed career pathway models to guide two-year college data science programs, but these efforts have proceeded more-or-less independently and from different perspectives. The goal of this project is to consolidate the results of the previous work and will allow a comprehensive look, from the perspective of a range of disciplines and employers, at the knowledge and skills that are needed in data science jobs. Outcomes will include a report summarizing the current state of data science programs at two-year colleges, the challenges that face those who are trying to launch such programs, and the further work and resources that are needed to increase the number of such programs; curricular guidelines for two-year college data science programs; and documentation of available resources for two-year colleges that are considering creating data science programs (NSF, 2017).

After several discussions with members of this project team, I was pleased to learn that I will be able to participate in both the planning and delivery of this workshop summit. In addition to presenting and possibly leading sessions at the workshop, there is a possible opportunity to be a member of the writing team who is tasked with authoring the outcome reports. As shown in the project proposal

(Appendix I), this project team consists of a variety of highly qualified and experienced experts in the field. Being a member of this team will provide invaluable insight and experience that can be applied to the development of a data analytics program at Delaware Technical Community College.

Chapter 5

REFLECTIONS ON LEADERSHIP DEVELOPMENT

Beginning of Ed.D. Journey

Before starting my journey in the Doctorate of Education program at the University of Delaware, I had already been working in education for more than ten years. From teaching high school mathematics at both public and private institutions, to writing and editing academic textbooks, and most recently to teaching mathematics and statistics at the college level. While my background was primarily in mathematics, I gained a comprehensive understanding of education as a field. Thankfully, I continued my pursuit of education as a life-long learner by enrolling in the Educational Leadership Ed.D. Program. Over the course of the next four years of study, I realized that while I may have had a passion for and extensive experience in teaching, I still had plenty of room to grow as a scholar, problem solver, and partner to become a true leader in the field of education.

Around the same time that I started thinking about a topic for my Educational Leadership Portfolio, I suggested the idea of developing a new data analytics degree program at Delaware Technical Community College. I had been teaching mathematics and statistics there as a full-time instructor for several years and began to think about where I could transition to once I was ready to move into a leadership position. Helping to develop a program, and then becoming the chair or coordinator seemed like a great goal toward which I could start moving. At first, the college recognized the potential need for such a program and established a small committee of faculty, researchers, administrators, and chairs to explore the feasibility of this new program. Unfortunately, through a series of circumstances, the exploratory committee did not

last longer than just a few meetings before the program was deemed unrealistic. This was primarily because there were no other community colleges offering such a degree program, and the college did not have the resources to conduct an occupational analysis of the data analytics field local to the region served by Delaware Tech.

But while this setback appeared to be insurmountable for the data analytics exploratory committee, it merely provided me with an exciting and challenging topic to undertake as my educational leadership project for the Ed.D. degree at the University of Delaware. And so began the journey of more carefully exploring the feasibility of, and developing, one of the first data analytics A.A.S. degree programs in the United States.

My Growth as a Scholar

Earning a master's degree in pure mathematics is no small feat, and it's one of the greatest accomplishments of my life. During that program, I often began coursework knowing absolutely nothing about the content in which I was about to be absorbed. It would take extreme focus, effort, and patience to move from novice to expert with very challenging, theoretical, and abstract content. To be honest, when starting the Ed.D. program in Educational Leadership, I did not expect the same transformation to take place, or even be necessary.

It was fortunate however, that one of my first courses in the program was a course dealing with academic research. And this was not just book reports, or report summaries, but an extensive and professional report that was to meet the standard for academic publication. This provided me with the realization that I did not know exactly what I was doing and had just as much to learn here as I did in pure mathematics. By the end of the course, I was able to draft, edit, evaluate, and produce

a 70-page research paper complete with a literature review, data analysis, study limitations, and recommendation. These were all skills that were completely new to me, but in the end, gave me the same feeling of accomplishment as completing real analysis proofs or non-Euclidean geometry constructions. I was lucky to have this experience early in the program as it humbled me as a student of education, allowed me to produce professional quality work that I did not know I was capable of, and also gave me the ability to continue conducting and producing professional research throughout the rest of the program.

Along with learning how to become an effective academic researcher, there are numerous other concepts and skills that I have been able to explore throughout the Ed.D. program, only to then apply them to authentic problems in my career. These include the analysis and writing of educational policy, conducting program evaluation for improvement, effectively analyzing and interpreting data, and incorporating educational technologies and strategies into my teaching. In order to demonstrate proficiency in these areas, and to offer a nod of appreciation and recognition to each of the University of Delaware professors that have contributed to my growth in these areas, I made a conscious effort to include all of these skills somewhere within my ELP project.

While this Ed.D. experience has been challenging, fulfilling, and empowering, the conclusion is certainly proving to be bittersweet. While on one hand, I feel like I'm just getting started on my journey of scholarship as an educational leader and still have so much more to learn, I am also finishing with the confidence that I can effectively utilize the knowledge, skills, and abilities to be successful in any future scholarship opportunities I will pursue as a life-long learner.

My Growth as a Problem Solver

It is one thing to solve exercises and evaluate solutions in an academic setting, but it is entirely different to be an effective problem solver in the complicated and messy environments of professional industry, academic institutions, and government organizations. In my opinion, the greatest advantage of University of Delaware's Ed.D. Program is that students are encouraged to tailor their coursework and projects to solve authentic problems within their respective educational context. At the time of the initial proposal for my ELP topic, I was hoping to take on a problem that no institution in the country had yet attempted to solve. Before the development of a new data analytics associate degree could be considered, it had to be established that the concept itself was even possible. Despite doubts from both administrators at Delaware Technical Community College, and faculty from the University of Delaware, I'm proud to say that I was able to make significant progress in moving from something that did not exist, to a feasible and realistic degree program with achievable outcomes to serve the needs of the local region.

One of the challenges throughout this process was in convincing internal and external stakeholders that there were emerging trends and changes in the labor market that will sufficiently validate the need for the development of this new data analytics program. It was with a sense of vindication and accomplishment that I learned that the National Science Foundation has recently awarded a grant to a partnership group of the American Statistical Association (ASA) and the American Mathematical Association of Two-Year Colleges (AMATYC) to explore the feasibility of data analytics programs at community colleges and develop curriculum guidelines for the development of such programs. And although their project was independent from, and initiated after my ELP research began, their proposal establishes goals and objectives

that are very similar to what I proposed three years ago. The outcomes of this grant funded project are to produce a report summarizing the current challenges faced by those working to develop two-year data science programs, as well as curating and writing resources help overcome these challenges. Additionally, the project team will create a set of guidelines for two-year data science programs that serve the various target populations of community colleges. I was honored and humbled to be invited to be a visiting member of the committee based on this ELP research, and will take part in the completion of this project during the Summer of 2018. This will be an excellent opportunity to apply the problem-solving techniques and skills learned throughout my Ed.D. program to an authentic problem that can be applied at academic institutions across the county.

My Growth as a Partner

As a community college instructor, it is very common to work independently for the majority of the time. Instructors often develop their own lecture notes, maintain their own class websites, write their own assessments, and then grade on their own. This was certainly true for me when I started the Ed.D. program four years ago. The first thing that I really appreciated about this program was the variety of backgrounds of my colleagues. As each course progressed, I was able to collaborate with principals, teachers, administrators, policy makers, students, and professors. These interactions provided an invaluable experience to learn about the field of education from a variety of perspectives.

These experiences proved useful as I changed my role during the last year of my Ed.D. program. In the Fall of 2016, I left the mathematics department to become a college-wide instructional designer. This was an exciting opportunity not only because

it was a much more dynamic and creative position, but it would require me to collaborate with a variety of colleagues on a daily basis. This could come in the form of working with other instructional designers, presenting policy to the President's Council, debating best practices with academic deans, or guiding department chairs and faculty through the distance education course design process. Having worked with such motivated and inspirational colleagues throughout the Ed.D. program certainly provided me with the confidence to be successful in this new endeavor.

I also look forward to making new connections and strengthening partnerships not only as I continue working in my role as an instructional designer, and as a member of the ASA/AMATYC data science project committee, but in the experiences that come to me in the future. I am certainly grateful for the connections I have made within the Ed.D. program, and for the skills and confidence to establish equally valuable partnerships outside of the program.

While it may be a longshot, there is a possibility that Delaware Technical Community College will again explore the possibility of developing a new data analytics degree program and become one of the first community colleges in the country to do so. I am proud that my work as a professional scholar, problem-solver, and partner in University of Delaware's Ed.D. program resulted in a map that can be used to guide the institution forward through reliable research, innovation, collaboration, and progress.

REFERENCES

- AACC. (2012). Reclaiming the American dream, community colleges and the nation's future: a report from the 21st-Century Commission on the Future of Community Colleges. Washington D.C.. American Association of Community Colleges
- Aasheim, C., Williams, S., Rutner, P., & Gardiner, A. (2015). Big data analytics and data science undergraduate degree programs. *Journal of Information Systems Education*, 26(2).
- AMATYC. (2015). American Mathematical Association of Two-Year Colleges. ASA Amatyc Joint Session Meeting Notes. July 6, 2015.
- ASA. (2014). Curriculum Guidelines for Undergraduate Programs in Statistical Science. American Statistical Association.
- BHEF. (2017). Investing in American's data science and analytics talent. Business Higher Education Forum.
- Booze. (2013). The field guide to data science. Booze Allen Hamilton. Tysons Corner, Virginia.
- Cárdenas-Navia, I., & Fitzgerald, B. K. (2015). The Broad Application of Data Science and Analytics: Essential Tools for the Liberal Arts Graduate. *Change: The Magazine of Higher Learning*, 47(4), 25–32.
- Cegielski, C. G., & Jones-Farmer, L. A. (2016). Knowledge, Skills, and Abilities for Entry-Level Business Analytics Positions: A Multi-Method Study. *Decision Sciences Journal of Innovative Education*, 14(1), 91–118.
- CIRWA. (2015). Computer and Information Technology Occupational Analysis. Delaware Technical Community College. Wilmington, DE.

- Davenport, T. H., & Patil, D. J. (2012). Data scientist: the sexiest job of the 21st century. *Harvard Business Review*, 90(10), 70–77.
- De Veaux, R. D., Agarwal, M., Averett, M., Baumer, B. S., Bray, A., Bressoud, T. C., Sethi, R. J. (2017). Curriculum Guidelines for Undergraduate Programs in Data Science.
- Delaware Economic Development Office. (2017). Delaware. Retrieved from <http://dedo.delaware.gov>
- Delaware Technical Community College. (2014). Fact Book 2013/2014. Dover, Delaware.
- Delaware Technical Community College. (2016a). About. Retrieved from <https://www.dtcc.edu/about>
- Delaware Technical Community College. (2016b). Mission. Retrieved from <https://www.dtcc.edu/about/mission-vision-and-strategic-directions>
- Delaware Technical Community College. (2016c). Strategic Directions. Dover, Delaware. Retrieved from <https://www.dtcc.edu/about/mission-vision-and-strategic-directions>
- Delaware Technical Community College. (2017). Curriculum Guidelines. Dover, Delaware. Retrieved from https://efiles.dtcc.edu/CURR_GUIDE
- Dumbill, E., Liddy, E. D., Stanton, J., Mueller, K., & Farnham, S. (2013). Educating the Next Generation of Data Scientists. *Big Data*, 1(1), 21–27.
- Education Advisory Board. (2015). State Employer Demand Dashboards.

- Hardin, J., Hoerl, R., Horton, N. J., Nolan, D., Baumer, B., Hall-Holt, O., ... Ward, M. D. (2015). Data Science in Statistics Curricula: Preparing Students to “Think with Data.” *The American Statistician*, 69(4), 343–353.
- NSF. (2017). Award Abstract #1735199. Retrieved from https://www.nsf.gov/awardsearch/showAward?AWD_ID=1735199
- Provost, F. & Fawcett, T. (2013). Data Science and its Relationship to Big Data and Data-Driven Decision Making. *Big Data*, 1(1), 51–59.
- SHRM. (2016). Jobs of the Future: Data Analysis Skills Table of Contents. Society for Human Resource Management.
- Stassen, M., Doherty, K., & Poe, M., (2001). Program-Based Review and Assessment: Tools and Techniques for Program Improvement. *Office of Academic Planning and Assessment*. Amherst
- Wake Tech Community College. (2017). Analytics. Retrieved from www.waketech.edu/programs-courses/credit/business-analytics
- Young, D. S., Johnson, G. F., Chow, M., & Rosenberger, J. L. (2015). The Challenges in Developing an Online Applied Statistics Program: Lessons Learned at Penn State University. *The American Statistician*, 69(3), 213–220.
- Zhao, J., & Zhao, S. Y. (2016). Business analytics programs offered by AACSB-accredited U.S. colleges of business: A web mining study. *Journal of Education for Business*, 91(6), 327–337.

Appendix A

EDUCATIONAL LEADERSHIP PORTFOLIO PROPOSAL

Overview

In his 2008 speech at the Innovating with Information Conference, Google Chief Economist Hal Varian declared that data science would be the dream job of the next decade. “What is getting ubiquitous and cheap? Data. What is scarce and expensive? The talent to be able to analyze that data and make it tell its story” (Young, Johnson, Chow, & Rosenberger, 2015). As demand for skilled, knowledgeable employees has increased among industries associated with data and analytics, some colleges and universities have started developing and offering programs in data science and analytics.

Delaware Technical Community College (DTCC) is currently among the majority of institutions of higher education that does not offer degree programs or certifications in data science or analytics. This Educational Leadership Portfolio (ELP) is designed to address that absence by researching industry needs for entry-level positions in the fields of data analytics nationally and regionally, and by proposing a program of study that would be among the first of its kind nationally. This unique associate level degree program will be informed by emerging trends in data analytics, industry requirements, current academic standards, and institutional goals. Graduates will be prepared to collect, analyze, interpret, and visualize the ever growing amount of data that is now available to organizations working to improve through data science.

Data science is the science of planning for, acquisition, management, analysis of, and inference of data through the creation of data products and analysis (De Veaux

et al., 2017). This is usually accomplished through some combinations of statistics, computing, and business analysis (Hardin et al., 2015). While the term “data science” first appeared in computer science literature in the 1960s, it was not until the late 1990s that the field began to emerge and separate itself from the statistics and computer science disciplines as analysts began dealing with much larger data sets and requiring quicker decision making processes. It became necessary to forego the theoretical statistics of the past and implement computer science techniques to begin coding algorithms to manage, analyze, and predict with big data. Data science was first introduced as an independent discipline in 2001, and has since had countless articles, reports, and papers advancing the discipline (Booze, 2013). It has even been declared in the *Harvard Business Review* as the “sexiest” job of the 21st century (Davenport & Patil, 2012).

While statistical analysis and data analytics are often used interchangeably, data analytics extends the focus to the analysis of larger data sets gathered from a wide variety of data sources (Davenport, 2013). In expanding the scope of traditional statistics, most in the industry now consider machine learning and data mining as important aspects of data analytics. It therefore follows from the definition of data analytics that 'business analytics' is actually data analytics, but applied within a business context. Closely related to the application of data analytics is the field of “data science”, which many say has been newly defined to apply data analytics skills to further address emerging issues such as dealing with big data (Aasheim, et al., 2015).

The field of ‘Data science’ has been defined as a set of fundamental principles that support and guide the principled extraction of information and knowledge from

data (Provost and Fawcett, 2013). Data science takes a multidisciplinary approach to the big data problem: not only is the data scientist skilled in data analytics, but should also be able to develop and test analytical algorithms, systems and applications through coding and programming at a high level (Dumbill et al., 2013). Additionally, a true data scientist would be expected to have excellent business skills to be able to judge the value of outcomes generated from analysis and to ensure that applications address intended business problems (Provost and Fawcett, 2013).

Though there may be subtle and debatable differences between the concepts of data science and data analytics, for the purposes of this study, the terms may be used interchangeably, depending on the source. After careful analysis of industry needs, curriculum guidelines, and the resources and goals of Delaware Technical Community College, it will later be determined if the title of this proposed program will be data science or business analytics.

Problem Statement

Previous studies (Aasheim, Williams, Rutner, & Gardiner, 2015; Hardin et al., 2015) have shown that very few colleges and universities across the U.S. offer data science and analytics programs at varied academic levels. Additionally, research indicates that by 2018, the U.S. alone will face a shortage of 140,000 to 190,000 professionals with the necessary analytical skills to make effective decisions (Zhao & Zhao, 2016). Currently, Delaware Technical Community College does not offer any programs in data science or analytics. It is the purpose of this Educational Leadership Portfolio (ELP) to research the industry needs for entry-level positions in the fields of data analytics, both nationally and specific to the regions served by Delaware Tech, to conduct program evaluations on comparable programs, and to develop a new program

proposal following the guidelines and standards set forth by Delaware Technical Community College.

In a joint study conducted by the American Statistical Association and the Society for Human Resource Management (SHRM, 2016), researchers aimed to cover the supply and demand of workforce development in the data analytics field while identifying key skills necessary to meet industry needs. Their findings show that 82% of organizations currently have positions in the data science field, with 59% indicating that they expect the number of required positions to grow over the next five years. The most common fields for these positions are accounting and finance (71%), human resources (54%) and business administration (50%), with 60% of organizations across all sectors requiring senior management to have data analysis skills. As this is certainly a positive indicator for the field as a whole, researchers also found that within the last year, more than 78% of organizations reported difficulty in effectively recruiting for these critical data analytics positions.

A 2011 report by the McKinsey Global Institute noted that the data industry is growing at a rate of 40% each year and predicts that by 2018, the United States will face a talent gap of 50-60% relative to supply, as well as a deficit of 1.5 million managers and analysts who can effectively analyze data for purposes of decision making (Cárdenas-Navia & Fitzgerald, 2015). Davenport and Patil (2012) similarly suggest that there is scarcity of people with the unique skill set (math, statistics, probability, programming, and business skills) to deal with data. As such, institutions of higher education, including community colleges, must be at the forefront in preparing students to meet these industry needs. In 2014, The American Association of Community Colleges (AACC) published their implementation guide to improve

and empower the nation's community colleges. In *Empowering Community Colleges to Build the Nation's Future*, they recommend that to close the skills gap, community colleges will need to build capacity for identifying unfilled labor market needs and ensure that career education and training programs are targeted to address those high-need areas. One way to do this is building local, regional, and national partnerships (involving community colleges, employers, and government agencies) to accomplish a collaborative agenda that includes targeting skills gaps, promoting the associate degree as a desired employment credential, and establishing alternative models for completing skills-based credentials (AACC, 2014). The primary goal of this study is to research the most effective and efficient ways to move Delaware Technical Community College in this direction within the context of a new data analytics degree program.

While there is extensive research to highlight the need for qualified data scientists at the national level, there is also research to show a similar need in the local regions served by Delaware Technical Community College. In the most recent state of Delaware labor market demand report released by the Education Advisory Board, it was found that data scientists and business analysts are experiencing high demand with emerging employers, and data science skills make up four of the top five “fastest growing skills” that employers are looking for. Similar trends were also found for the surrounding states of Pennsylvania, Maryland, and New Jersey (Education Advisory Board, 2015). Additionally, a similar 2015 study conducted by Burning Glass Labor found over 3,000 online job postings in 13 counties in and around Delaware that were advertising for data science and business analytics positions (CIRWA, 2015). But

considering the speed at which the field is growing, it is likely that these numbers already underestimate the current need.

The continuous improvement of technologies and techniques in data science are transforming organizations into data intensive enterprises, but despite the resulting demand for experienced and knowledgeable graduates in the field, undergraduate education has been slow to respond. Currently, most data science instruction found at four-year higher education institutions is still housed within schools of engineering or computer science, largely limiting these crucial skills and opportunities to STEM graduates (Cárdenas-Navia & Fitzgerald, 2015). It is clear that colleges and universities should begin developing degree programs that will produce qualified graduates who can apply a variety of tools and techniques to manage and identify patterns in unstructured data while applying analytics to gain business insights that lead to improved decision making. Although academia is working to develop relevant programs, the supply of appropriately skilled graduates still lags behind the demand (Dumbill, Liddy, Stanton, Mueller, & Farnham, 2013). Given that data science and analytics is a multi-disciplinary field, workers will require a variety of talents, knowledge and skills. Because of this, a variety of degree programs will be needed at all levels of education, not just at the graduate levels (Aasheim et al., 2015).

The current state of supply and demand in the data science field presents an excellent opportunity for Delaware Technical Community College. While there is clearly a need for qualified graduates capable of filling various needs in the industry, there is a shortage of academic institutions locally available to train these students. According to the Delaware Economic Development Office, more than half of all U.S. public companies are incorporated in the Delaware, including 60% of all Fortune 500

companies. This includes prosperous industries ranging from aviation and agriculture to financial services and chemical manufacturing (Delaware Economic Development Office, 2017). So, as one of the primary missions of DTCC is create beneficial partnerships with local industry to produce a more qualified workforce, there should be plenty of opportunities to contribute to the solution of this problem within a new data analytics degree program.

One of the primary challenges of this project is to consider the perceptions of the same industries that Delaware Tech serves and with which it strives to develop partnerships. Recent studies (Cegielski & Jones-Farmer, 2016; CIRWA, 2015; SHRM, 2016) have demonstrated that the majority of job postings for data science positions, both locally and nationally, currently stipulate either bachelors or masters degrees as minimum requirements. While this initially appears that it could be a roadblock for the effectiveness of this proposed program, additional information in these postings instead offers strong support of this proposal. It is the position of this study that the human resource specialists charged with composing these job postings select minimum degree requirements as an arbitrary default and may not be fully informed as to what degree level is realistically needed to achieve the desired skills and abilities. Because data science is an emerging field, human resources professionals may not be acquainted with the nuances of data analytics training and qualification, so defaulting instead to a minimum degree requirement in the recruitment process is a possibility. The vast majority of these posts also list the required and desired skills, which may not directly correlate with or justify the minimum degree requirements. In a recent 2017 report, the Business Higher Education Forum noted that when it comes to the field of data science, the practice of treating degrees as proxies for skill sets is no longer

effective, as hiring managers may not be fully aware of the common nomenclature to converse in data science competencies and skills (BHEF, 2017). One goal of this project is to determine, through research and executive interviews with local industry professionals (see Appendix A), how these degree requirements are considered, and what priority and weight is placed on demonstrable skills versus degree level.

Various research shows that these primary skill requirements are knowledge of Excel, SQL, SAS, R, Python, SPSS, data mining and visualization, and predictive analysis (Cegielski & Jones-Farmer, 2016; Dumbill et al., 2013; Zhao & Zhao, 2016). One of the goals of this project is to develop a program in which all of these skills could be sufficiently mastered within the proposed two-year project-based curriculum. So, it will be helpful to communicate with local industry to determine what requirements, experience, and skills are necessary for graduates with associate degrees in data science to secure gainful employment. Consider, for example, a local financial institution recruiting for an entry-level data scientist with proficiency in SQL, SAS, R, and regression modeling. While the job posting currently includes a minimum degree requirement of bachelor's or master's degree, this institution may consider changing that requirement if it were confident that graduates from the new A.S. degree in data science from DTCC demonstrated mastery of the desired skills. As Hal Varian pointed out in his 2008 speech, the talent to analyze data and tell its story is scarce. Delaware Technical Community College can provide those skills in the context of a two-year associate degree in data science, thereby providing a much needed service to its students and the region.

Organizational Context

Delaware Technical Community College (DTCC) is an open-admission, two-year institution that grants diplomas, workforce development certificates, and associate degrees. It is the only community college in the state of Delaware and currently has four campuses across the state in Wilmington, Stanton, Dover, and Georgetown (Delaware Technical Community College, 2016a). As of 2016, the college's total enrollment included 13,471 students, 4,740 of whom were full-time. The college population is 60% female, and 40% male, with approximately 56% of students reporting as Caucasian, 24% as Black or African-American, 10% as Hispanic or Latino, 3% as Asian, and 7% reporting as "other" or not indicating. The average student age is 25 years old, while the full-time student population has an average age of 22. For the class of 2016, DTCC awarded 1,698 associate degrees, 258 certificates, and 92 diplomas (Delaware Technical Community College, 2017).

The mission of DTCC is to offer comprehensive educational opportunities that contribute to the economic vitality of the state of Delaware. The institution aims to do this by preparing students with knowledge and skills needed for employment in a competitive workforce across a range of occupational levels (Delaware Technical Community College, 2016b). The Strategic Directions of the College provide focus for the institutional goals, which are in turn are relevant to the purpose of this Educational Leadership Portfolio (ELP). Among these Strategic Directions are to strengthening and developing programs that demonstrate a strong student-centered focus, expanding and leveraging financial, operational, and partnership resources to meet increased workforce demand, and providing innovative programming that prepares competitive graduates for Delaware's business and industry (Delaware Technical Community College, 2016c). The design and implementation of a data science program of study

embodies this mission because it expands the opportunity of DTCC students within the workforce and simultaneously contributes to Delaware's economic vitality.

As DTCC strives to prepare graduates for an ever-changing job market using the lens of the Strategic Directions, many of the highlighted trends and recommendations underscore the work of this ELP and specifically the development of a new data science program. Specifically, the College notes that workers will require higher level math skills and more creative mathematical thinking to help companies compete in a global economy, while also meeting the increased demand of professionals with technology skills (Delaware Technical Community College, 2016c). Given these considerations, one of the objectives of a new data analytics program is to fully consider these Strategic Directions and goals of the College when developing industry partnerships, rigorous curriculum designs, and authentic assessments.

Organizational Role

As an instructor, content expert, and instructional designer at Delaware Technical Community College, I am in a unique position to lead, inform, and support the development of a new data analytics degree program which could bring about positive change to the organization as a whole. And while a project of this size and scope requires the coordination and cooperation of many different departments and stakeholders, my roles within the college have prepared me to offer insight on how many of the final components can be orchestrated to create a successful program.

The initial idea for this project, and the development of a data analytics program at Delaware Tech, began in the Fall of 2015. At this time, my role at the college was that of a full-time faculty member in the Mathematics Department at the

Wilmington Campus. In addition to the regular course load duties of a mathematics instructor, I was also the “course leader” for Statistics I and II. Within the DTCC mathematics department, a course leader is responsible for determining the content of the course, creating or revising the syllabi, selecting course resources, and developing fair and effective assessment strategies. So, for my first few years as an instructor, much of my time was spent researching best practices in statistics education to be adapted and implemented at the community college level with the goal of improving overall student success at DTCC.

While students enrolled in my Stat I and II courses come from different backgrounds and have different majors, all students learn many real-world statistical techniques using authentic data. This includes introductory data analysis, probability, hypothesis testing, regression, analysis of variance, and modeling. The content and concepts found in these courses are also required for many aspects within a data analytics program. According to the *Curriculum Guidelines for Undergraduate Programs in Data analytics*, key competencies for an undergraduate data analytics major include informal linear modeling, probabilistic thinking, estimation and testing, and graphical data analysis methods (De Veaux et al., 2017). As there are certainly other required competencies for a data analytics program, including computer science, machine learning, and databases, my content knowledge of mathematics and statistics will be useful in developing effective course sequences for a new program in data analytics.

In January 2017, I accepted a new position at the college as an instructional designer with the Center for Creative Instruction and Technology (CCIT). While the role of an instructional designer can vary depending on the institution, my primary

roles are to assist faculty with implementing best practices in teaching, develop and evaluate distance education offerings, and work with academic departments as they redesign their curriculum. I believe that my experiences with all of these will help better prepare me to work with faculty as we develop new course sequences, assessments, and teaching strategies. In order to design and develop this new data analytics program, there will be many questions and challenges that an instructional designer will be equipped to handle. These include communicating with various departments, developing individual courses to support the program as a whole, helping faculty to create authentic assessments, and determining how distance education technologies will be utilized for various courses.

Improvement Goal

The proposed associate degree program in data analytics will be designed to meet the growing workforce demand and to provide students with the skills necessary for gainful employment in analytical career fields. This program will be interdisciplinary in nature and will include content from computer science, mathematics, and business. The curriculum will be hands-on and application based with authentic assessments informed by partnerships with local and national industry. In order to ensure industry consistency and improve opportunities for articulation and transfer agreements, nationally recognized research and standards such as the Guidelines for Assessment and Instruction in Statistics Education (GAISE), and the American Association of Community Colleges (AACC) will be consulted. These national standards for statistics and data science have been developed because traditional statistics curricula have not kept up with pressing demands for graduates

who can make sense of data, and will therefore be used to inform program curriculum design for the new AS in data analytics at DTCC.

Community colleges are a growing and increasingly important component of the higher education system and have been the platform from which millions of low and middle-income Americans have launched their careers, and dreams. However, this American dream is at risk. As described in the 2012 report by the American Association of Community College, median income in the United States stagnated between 1972 and 2000, and has since declined by 7%. In today's society, a child born poor in the United States today is more likely to remain poor than at any time in our history. But as a highly educated population is fundamental to economic growth and a vibrant democracy, community colleges can help students reclaim that dream. At their best, they provide America with a capacity that few other advanced industrial economies enjoy: the ability to rebuild the workforce, reinforce connections between education and the economy, and reverse the decline of the middle class through meaningful education, experiences, and employment. But meeting this challenge will require dramatic redesign of community college programs, their mission, and their students' educational experiences within many disciplines, including data analytics.

Additional research and efforts will be needed to improve statistics and data science instruction at the two-year college level, raise the profile of statistics majors at these institutions, and facilitate articulation agreements for transfer to four-year institutions (ASA, 2014). The number of students studying introductory statistics courses at community colleges has increased to more than 137,000 per year. This reflects the belief that statistics is a universal discipline, not just needed for a handful of students at the graduate levels, but required for a number of disciplines and

recommended for many others. The American Statistical Association recommends that both industry and universities alike should streamline articulation agreements with community colleges and to support faculty development and curricular development at two-year colleges to meet this increasing need.

During a recent joint committee meeting between the American Association of Two-Year Colleges and the American Statistical Association, a project was proposed to address the feasibility of a data analytics curriculum for community colleges. The questions raised were concerned with the marketability of a two year associate data analytics degree, the resources needed to support these new programs, and the prior arrangements with four year schools and/or local industry (AMATYC, 2015). While the results of this research are still pending, this joint project illustrates that the development of data analytics programs at community colleges is a pressing professional consideration by the relevant national organizations, and illustrates how Delaware Technical Community College has an exciting opportunity to be one of the pioneering institutions to meet this challenge.

Another important component of this proposal will be the examination of data analytics programs at peer institutions. Currently, there appears to be only one existing associate level degree program in data analytics. Wake Tech Community College, located in North Carolina, began offering an associate degree in data analytics in the Fall of 2013. The program is fully accredited and qualifies students for employment as data scientists and analysts in the fields of finance, logistics, healthcare, manufacturing, information technology, and government (Wake Tech Community College, 2017). This program will be evaluated to determine if any best practices can be effective for the development of a new program at Delaware Technical Community

College. As more and more institutions are now considering the need for data science programs, if any new associate degree level programs are found in addition to Wake Tech, they will also be examined in a similar manner.

As previously discussed, there is a local, regional and national demand for qualified graduates with data science skills, and Delaware Technical Community College could satisfy a unique portion of that need through the development of an associate level degree program. While there will always exist an argument that data scientists need to have graduate level degrees, the goal of my ELP research will be to argue that by following guidelines set out by the industry, successful graduates of this proposed program will be able to obtain gainful employment in a variety of industries, or be in an excellent position to continue their data analytics education at a four-year institution. The action steps for this study are shown in Table 2, with the resulting artifacts described in Table 3. While my overall goal and vision is to ultimately design and develop this new degree program at DTCC, the intention of this proposal is to carry out the groundwork necessary to explore what such a degree program would look like, how it would interact with existing departments and stakeholders, and what type of industry partnerships could be established if the program were implemented at Delaware Technical Community College.

Table 2 ELP Proposal Action Steps

Part I – Feasibility Study
<ol style="list-style-type: none">1. Conduct research on the current state of professional data science and analytics.2. Collect and analyze data analytics industry needs at the national and local levels.3. Conduct executive interviews with local industry to determine desired skills and degree attainment; Obtain feedback on possibility of changing degree requirements of current/future job postings.4. Research other data analytics educational options in the area served by Delaware Technical Community College.5. Examine current mission and structure of Delaware Technical Community college to determine how proposed program may fit most efficiently and effectively.
Part II – Curriculum Development
<ol style="list-style-type: none">6. Research existing academic programs (including undergraduate and graduate levels) in data analytics.7. Conduct program evaluation of A.A.S. data analytics program at Wake Tech Community College.8. Conduct curriculum development sessions with college and industry representatives to identify the skills, knowledge, and attributes that the workforce requires of graduates.9. Articulate high level program outcomes and develop curriculum using backward design principles.10. Write course descriptions for new and existing courses within the proposed program.11. Create official program course sequence sheet.

Part III – DTCC Program Proposal

12. Curriculum and course program sheet submitted to industry representatives and potential partners for feedback.
13. Write A.S. Data analytics white paper to support case for offering new degree.
14. Compile and present findings as new program proposal following Delaware Technical Community College requirements.

Part IV – Program Review Analysis

15. Develop a five-year program review assessment plan of the DTCC Data Analytics Associate Degree Program to ensure that the mission and strategic directions of the college are being met by the program.
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Table 3 ELP Proposal Artifact Table

Artifact	Type	Description	Action Step(s)
Industry needs research (Occupational Analysis)	Mixed-method study/audit presented as report from Research in Educational Decision Making EDUC828	The goal of this research is to author a report and provide analysis and recommendations regarding the region's Data Analytics occupations. I will estimate regional employment needs and growth, determine employer needs, and identify interest in cooperative program opportunities. This will be achieved through content analysis, survey responses, and interviews.	This artifact is the result of action steps 1, 2, 3

Artifact	Type	Description	Action Step(s)
The Case for offering AAS in Data Analytics	White Paper	This is a required document when proposing a new degree program at Delaware Technical Community College. This summary document will provide a brief background of Data Science and Analytics, the impact that the program will have on the state of Delaware, and how it fits with the mission of DTCC.	This artifact is the result of action steps 1, 2, 5, 13
Course sequence sheet w/ descriptions	Curriculum Design from EDUC897: Curriculum	Using instructional design and curriculum development strategies explored throughout the Ed.D. Program, the entire degree program for the Data analytics A.A.S. will be developed and proposed. The courses in this program will be informed from research and other artifacts to justify their inclusion in the A.A.S. degree.	This artifact is the result of action steps 2, 3, 6, 7, 8, 9, 10, 11
Case Study of Business Analytics at Wake Tech	Case Study and Evaluation	At the time of this research, there is currently only one community college in the U.S. offering an A.A.S. degree in Data Analytics. Through a variety of communications and data sharing, a program evaluation will be completed at Wake Tech Community College to help inform this new program proposal.	This artifact is the result of action steps 7

Artifact	Type	Description	Action Step(s)
A program review assessment plan of the proposed DAS AAS degree program at DTCC	Assessment Plan	Develop a five-year assessment plan of the DTCC Data Analytics Associate Degree Program to ensure that the mission and strategic directions of the college are being met by the program. This will specify operational and student level outcomes, assessment strategies and guidelines, and will provide ongoing improvement for the program.	This artifact is the result of action step 15
College-wide Proposal for new program	Program proposal meeting DTCC requirements	This proposal will be the final artifact and will consist of all required components for a new degree program proposal at Delaware Technical Community College. Included in this proposal will be aspects and summaries of other artifacts, as well as additional analysis and reporting to support the feasibility for this new program. This will be presented as a professional document in accordance with DTCC policy requirements.	This artifact is the result of action steps 1 - 14

References

- AACC. (2012) . Reclaiming the American dream, community colleges and the nation's future: a report from the 21st-Century Commission on the Future of Community Colleges Washington D.C.. American Association of Community Colleges
- Aasheim, C., Williams, S., Rutner, P., & Gardiner, A. (2015). Big data analytics and data science undergraduate degree programs. Decision Sciences Institute.
- AMATYC. (2015). American Mathematical Association of Two-Year Colleges. ASA Amatyc Joint Session. July 6, 2015.
- ASA. (2014). Curriculum Guidelines for Undergraduate Programs in Statistical Science. American Statistical Association.
- BHEF. (2017). Investing in American's data science and analytics talent. Business Higher Education Forum.
- Booze. (2013). The field guide to data science. Booze Allen Hamilton. Tysons Corner, Virginia.
- Cárdenas-Navia, I., & Fitzgerald, B. K. (2015). The Broad Application of Data Science and Analytics: Essential Tools for the Liberal Arts Graduate. *Change: The Magazine of Higher Learning*, 47(4), 25–32.
- Cegielski, C. G., & Jones-Farmer, L. A. (2016). Knowledge, Skills, and Abilities for Entry-Level Business Analytics Positions: A Multi-Method Study. *Decision Sciences Journal of Innovative Education*, 14(1), 91–118.
- CIRWA. (2015). Computer and Information Technology Occupational Analysis. Delaware Technical Community College. Wilmington, DE.

- Davenport, T. H., & Patil, D. J. (2012). Data scientist: the sexiest job of the 21st century. *Harvard Business Review*, 90(10), 70–77.
- De Veaux, R. D., Agarwal, M., Averett, M., Baumer, B. S., Bray, A., Bressoud, T. C., ... Sethi, R. J. (2017). Curriculum Guidelines for Undergraduate Programs in Data Science.
- Delaware Economic Development Office. (2017). Delaware. Retrieved from <http://dedo.delaware.gov>
- Delaware Technical Community College. (2014). Fact Book 2013/2014. Dover, Delaware.
- Delaware Technical Community College. (2016a). About. Retrieved from <https://www.dtcc.edu/about>
- Delaware Technical Community College. (2016b). Mission. Retrieved from <https://www.dtcc.edu/about/mission-vision-and-strategic-directions>
- Delaware Technical Community College. (2016c). Strategic Directions. Dover, Delaware. Retrieved from <https://www.dtcc.edu/about/mission-vision-and-strategic-directions>
- Dumbill, E., Liddy, E. D., Stanton, J., Mueller, K., & Farnham, S. (2013). Educating the Next Generation of Data Scientists. *Big Data*, 1(1), 21–27.
- Education Advisory Board. (2015). State Employer Demand Dashboards.
- Hardin, J., Hoerl, R., Horton, N. J., Nolan, D., Baumer, B., Hall-Holt, O., Ward, M. D. (2015). Data Science in Statistics Curricula: Preparing Students to “Think with Data.” *The American Statistician*, 69(4), 343–353.

Provost, F. & Fawcett, T. (2013). Data Science and its Relationship to Big Data and Data-Driven Decision Making. *Big Data*, 1(1), 51–59.

SHRM. (2016). Jobs of the Future : Data Analysis Skills Table of Contents. Society for Human Resource Management.

Wake Tech Community College. (2017). Analytics. Retrieved from www.waketech.edu/programs-courses/credit/business-analytics

Young, D. S., Johnson, G. F., Chow, M., & Rosenberger, J. L. (2015). The Challenges in Developing an Online Applied Statistics Program: Lessons Learned at Penn State University. *The American Statistician*, 69(3), 213–220.

Zhao, J., & Zhao, S. Y. (2016). Business analytics programs offered by AACSB-accredited U.S. colleges of business: A web mining study. *Journal of Education for Business*, 91(6), 327–337.

Appendix B

OCCUPATIONAL ANALYSIS OF DATA ANALYTICS

Introduction

Recent research indicates that by 2018, the U.S. alone will face a shortage of 140,000 to 190,000 professionals with the necessary analytical skills to make effective decisions (Zhao & Zhao, 2016). It is the purpose of this occupational analysis to research the industry needs for entry-level positions in the fields of data analytics, both nationally and specific to the regions served by Delaware Technical Community College (DTCC), to provide analysis and recommendations to better inform a new program proposal for a new A.A.S. degree in data analytics.

The research objectives aim to:

- Explore national employment trends in data analytics
- Estimate regional data analytics employment and projected growth
- Identify employer demand and preferred level of education for selected data analytics skills sets
- Assess hiring challenges for data analytics positions
- Determine regional employer needs

This will be accomplished through a mixed-methods analysis using research, content analysis, surveys, and interviews. The primary collection of data took place between October 2016 and August 2017. The report also includes secondary data from a variety of sources including the Bureau of Labor Statistics, Burning Glass, and LinkedIn.

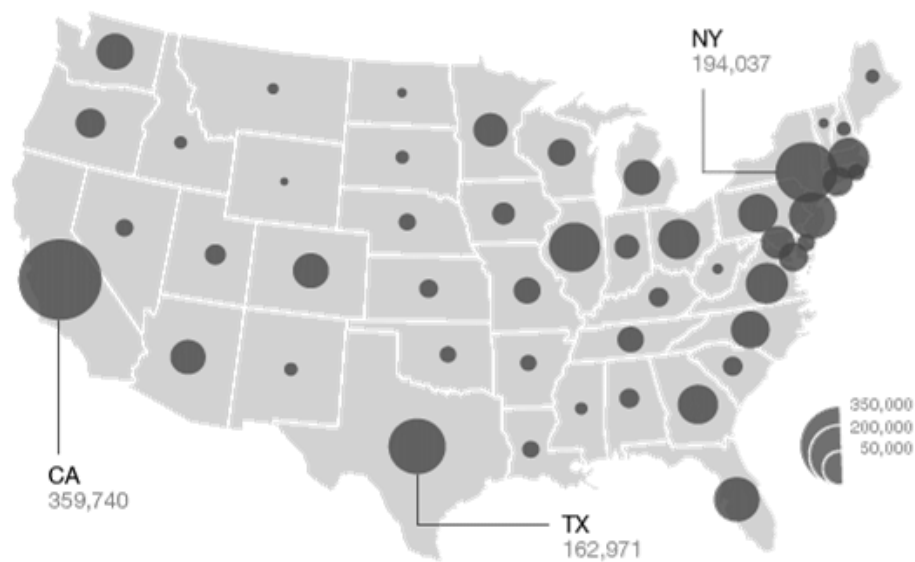
National Employment Overview

In a joint study conducted by the American Statistical Association and the Society for Human Resource Management (SHRM, 2016), researchers aimed to cover the supply and demand of workforce development in the data analytics field while identifying key skills necessary to meet industry needs. Their findings show that 82% of organizations currently have positions requiring data analytics skills, with 59% indicating that they expect the number of required positions to grow over the next five years. The most common fields for these positions are accounting and finance (71%), human resources (54%) and business administration (50%), with 60% of organizations across all sectors requiring senior management to have data analysis skills. As this is certainly a positive indicator for the field as a whole, researchers also found that within the last year, more than 78% of organizations reported difficulty in effectively recruiting for these critical data analytics positions. Additionally, a 2011 report by the McKinsey Global Institute noted that the data industry is growing at a rate of 40% each year and predicts that by 2018, the United States will face a talent gap of 50-60% relative to supply, as well as a deficit of 1.5 million managers and analysts who can effectively analyze data for purposes of decision making (Cárdenas-Navia & Fitzgerald, 2015).

In an effort to provide recommendations to industry for improving their access to data analytics talent, the data analytics consulting firm PriceWaterHouse-Cooper and the Business Higher Education Forum (BHEF, 2017) conducted a study to identify what industry sectors and regions were in the most demand for analytics. Researchers in this study were able identify the geographic areas where these job postings were located to illustrate hot spots of analytics jobs across the nation. These results indicate that there is significant demand not only across a variety of industries,

but also to those local to the region served by Delaware Technical Community College.

Figure 1 Map of Data Analytics Labor Demand (BHEF, 2017)



Skills Profile

With a strong emerging demand for employees who are skilled and knowledgeable in data analytics, some colleges and universities have started to offer programs in business analytics and data science. And given that analytics is a multi-disciplinary field, workers within this field will require a variety of talents, knowledge, and skills and a variety of degree programs will be needed. Given the media buzz associated with data science, a number of white papers, journal articles, and surveys have been published. These publications have attempted to identify trends, needs and current industry practices with respect to data science.

Employers consistently indicate that career success factor skills such as leadership, teamwork, and written and verbal communication are in great demand from students, in addition to the baseline of technical skills that are expected (Smucker & Bailer, 2015). In order to identify the relevant skills sets in relation to employer needs, a variety of sources were utilized to develop a starting point. The results of a national study (AnalyticsWeek, 2015) conducted by AnalyticsWeek and Business Over Broadway organizes 20 critical skills into different areas. These findings are presented in Table 4.

Table 4 Data Analytics Skill Areas

Skill Area	Skill Detail	
Business	Product design and development Business development	Project management Governance and compliance
Technology	Unstructured data (noSQL) Machine Learning (trees, nets) Big data (Hadoop, Map/Red.)	Structured data (SQL, XML)
Math & Modeling	Optimization (linear, convex, global) Math (linear alg., calculus)	Graphical models (networks) Algorithms & simulations
Programming	Systems administration (UNIX) Database admin (MySQL)	Cloud management Programming (JAVA, HTML)
Statistics	Data management (recoding, scraping) Data mining (R, Python, SAS, SPSS)	Modelling (ANOVA, GIS) Communication

Additional research supports that the primary skill requirements of data analytics are knowledge of Excel, SQL, SAS, R, Python, SPSS, data mining and visualization, and predictive analysis (Cegielski & Jones-Farmer, 2016; Dumbill et al., 2013; Zhao & Zhao, 2016). This research was used to inform the specific questions related to skill sets throughout the occupational analysis.

Regional Job Posting Skills Audit

Presently, Delaware Technical Community College does not offer any programs in data analytics. It is the goal of this portion of the study to research the local industry needs for entry-level positions in the fields of data analytics, specific to the local regions that Delaware Tech serves. The initial step was to search through the required skills desired by employers in current job postings found on popular job websites. These findings will further develop research questions and provide valuable information to conduct a feasibility study for the creation of data analytics programs at the community college level by exploring the question: ‘What technical knowledge and skills should be taught in a two-year program to prepare students for entry-level careers in data analytics’?

Research Design

This quantitative study explored the current climate of the data analytics industry through active job postings. The design of this research was primarily content analysis. This method is a technique that allows researchers to study different components of human interaction through written communications and has many applications in educational research. It requires examination of language for the purpose of classifying text into categories with specific meanings. This is typically

accomplished through the establishment of a coding schema that is used to classify and organize the content of interest prior to analysis. Additionally, this research design can be used to provide critical information to further develop a hypothesis, which can then be explored using more direct methods. In the case of this study, a content analytic approach was used to examine active job postings for entry-level data science and business analytics positions (Fraenkel, Wallen, & Hyun, 2012). Through this, the goal was to determine trends in required skills and abilities that employers are looking for in potential candidates.

A purposive sample was used for this study. To address the specific research question, entry-level job listings posted on four of the most used professional networking and employment sites (Indeed, GlassDoor, Career-BUILDER, and Monster) were selected for audit. These sites were selected as content sources because they each have a significant number of data analytics postings, as well as search options that could help to identify required skills of entry-level positions. Initial searches for jobs using the titles “data science” and “data analytics” yielded over 10,000 such active positions. Additional filters were used to limit the results to positions that are full-time, require fewer than 3 years of experience, and are within the local regions of Delaware, Pennsylvania, Maryland, and New Jersey. It is worth noting that these filters were put in place to support the specific research question of this study, ‘What technical knowledge and skills should be taught in a two-year program to prepare students for entry-level careers in data science’? There are certainly other desired skills prevalent in the fields of data science and business analytics, especially at the upper levels, but this study aims to identify the baseline knowledge and skills that can be mastered within the scope of a two-year program.

To help ensure the stability and reproducibility of the study, the primary data collected from this industry-needs audit was manifest content. By collecting the obvious surface content (words, descriptions, etc.) of each job posting, as opposed to any underlying or implicit meaning behind them, this should produce more reliable results. Since multiple professional job posting sites were used, the collection of job postings needed to be carefully reviewed to remove any duplicate postings.

The data found within the job postings were classified into two categories, a description of the business, and the desired skills of the employee. To code the data, previous research was reviewed to see how other investigators have researched job postings. Based on this, I adapted a coding method to identify the various technical skills as shown below in Table 5.

Table 5 Technical Knowledge and Skills Found in Job Postings

Technical Skills			
Knowledge related to specific software tools or hardware support	Applications	Languages	Infrastructure
	Excel	R	Hadoop
	SAS	Python	Cassandra
	Tableau	SQL Java	Oracle Linux
	RapidMiner	Other (?)	MapReduce
	SPSS		Hive
	Cognos		Pig
	QlikView		Other (?)
	Other (?)		

Filtered job postings were reviewed to determine if they are suitable for this study and address the primary research question. If so, they were categorized and counted using the technical skills instrument. At the conclusion of the audit,

frequencies and proportions of each occurrence were calculated and displayed. In applying frequency analysis to the data set found from the job postings, it is assumed that the most important or relevant skills required for entry level data science positions would appear with the highest frequencies in the data set. For example, if 76% of all job postings indicated that experience with SQL was a required skill, this would be useful information to have when developing the program and curriculum. So, as the purpose of this study is to identify trends in required technical skills in the industry, the use of frequency analysis is appropriate, and presents no foreseen limitations or validity issues.

Results

A total of 58 active job postings were identified as suitable for this study. This means that they have been verified through the specific company website, and indicate required skills. All of these postings are for positions in Delaware, and were identified using the search terms of “data analyst” or “data scientist”. A sample of the data collection instrument is shown in Table 6.

Table 6 Sample Jobs Audit Data

<i>City</i>	<i>Employer</i>	<i>City</i>	<i>Industry</i>	<i>Job Title</i>	<i>Degree</i>	<i>Skills</i>
Monster	Kforce	Newark	Accounting	Data Analyst	Bachelor	SAS, SQL, Excel, Oracle
Monster	JPMorgan Chase	Wilmington	Banking	Data Analyst	Bachelor	SAS, SQL, Excel, Essbase
Monster	Navient	Newark	Banking / Lender	Reporting Analyst	Bachelor or Exp	SAS, SQL, Excel, Hive
Monster	Christiana Care	Newark	Healthcare	Clinical Data Analyst	Bachelor or Exp	SQL, Excel, R Access, Unix
:	:	:	:	:	:	:
Indeed	Discover	New Castle	Banking	Data Analyst	Associate	SAS, SQL, Excel

(n = 58)

Based on these preliminary results, it is clear that specific trends exist as to what skills are required for data analyst positions. These findings will help inform what coursework should be included in the proposed program. And while these are preliminary results that warrant further research, the results of the skills analysis are provided in Table 7.

Table 7 Required Skills Found in Local Job Postings

Skill	Present in Posting (%)
SQL	87.9
SAS	65.5
EXCEL	53.4
Other (Python, R, Hadoop, Java, SPSS, etc.)	< 20.0

Recommended Use of Findings for Problem Solving

A key to success for any data analytics program is to integrate the concept of “learning by doing”. Analytics with big data requires real-world experience and insights that can only be generated by repeatedly addressing the issues in many different ways. Strong relationships and partnerships between academic programs and industry partners strengthens the experiential learning aspect of the educational program. It is for this reason that it is important to stay informed of what the industry needs from the future analysts. Data from this study will allow data science program leaders to communicate with industry and develop relevant project-based coursework.

Within the college itself, an important step in developing a quality program is specifying program level learning outcomes. These should be clear goals and skills that can be translated into specific, observable, measurable behaviors that can provide evidence of student learning and growth within the program. The data and trends found in this study can help the program and curriculum development committee at Delaware Technical Community College to develop more sound components that focus on the technical skills that will be most beneficial to graduates. Additionally, even if all of the relevant technical skills are not able to be included in the associate degree program, the results of this study can hopefully serve as guidelines for future studies for students who wish to pursue a career in data analytics.

Limitations of the Study

While this initial data collection process did yield some relevant information, it also presented a variety of challenges and limitations to this search method. When conducting research that relies on non-random sampling such as this, it is critical to consider external validity, and the extent to which the sample represents the

population as a whole. Because the job posting sites are considered to be four of the largest such sites, I was confident that this data collection method would be a fair representation of what skills local industry were requiring from applicants. However, while these popular job posting sites do provide filters to help narrow down searches to location, job title, and relevant skills, there appears to be a consistent lack of integrity in the resulting job postings. For example, the majority of results are formatted to appear like authentic job postings, but are actually links to external and unrelated websites. Additionally, many postings are not generated from actual openings, but are auto-generated using popular keywords and linked to other job posting sites or to generic recruiting firms. Based on these challenges and limitations, it was necessary to conduct additional research at the local level to establish a more informed skills profile and labor market.

Regional Professional Survey and Executive Interviews

Research Design

In order to gather more data concerning the skills and labor market, an additional study was designed in order to elicit information through both survey and interviews with professionals working in the field of data science and analytics. This mixed-method study provided both quantitative and qualitative data regarding the current labor market needs and skills. The industry based social network LinkedIn was used to identify potential participants for this research. This site was used because of its popularity among professionals in many sectors, as well as the advanced filtering features that can be used in identifying people within the data analytics industry.

The first criteria in selecting a potential sample group was to identify professionals from some of the larger employers in the region served by Delaware Technical Community College. These companies were intentionally selected across a variety of industry sectors. The applied filter provided professionals who listed any of the following companies as current or past employers (Table 8). An additional filter was applied to only return results of those who worked within 50 miles of Newark, Delaware. This was to ensure that the sample was representative of the local industry.

Table 8 Industry Sample

Industry Sector	Name of Company / Organization		
Financial	Barclays	Capital One	Bank of America
	JPMorgan	Wells Fargo	CitiBank
	Chase	Sallie Mae	M&T Bank
	B of A	Navient	
Chemical and Manufacturing	Dupont	FMC	BASF
	Croda	Gore	Agilent
	ILC Dover		
Pharmaceutical	AstraZeneca	Merck	Teva
	Siemens	GlaxoSmithKline	
Technology	Comcast	Delasoft	
Health	Christiana Care	Nemours	
Retail	QVC		

The other criteria for sample selection was the addition of a keyword filter. By adding the keywords of “data science”, “data analytics”, and “business analytics”, search results were limited to professionals who had these job titles or skills listed in their profiles. Of the returned results, 40 professionals were selected to be invited to

participate in both an informational survey and/or phone interview. While there were more people who satisfied the sample criteria, the number contacted was limited to 40 by the restrictions of the membership offered by LinkedIn. In order to increase the probability of increased responses, a purposive sample was utilized to select professionals with recent LinkedIn activity and complete profiles as preference. Each person was sent an email message through the LinkedIn site to participate in the survey and/or interview. Of the 40 professionals contacted, eight fully completed the survey and three agreed to participate in interviews. Information for these participants is provided in the Appendix.

Limitations of the Study

The ability to generalize data from this survey was limited to the quality of the sample frame. Specifically, this research utilized only the respondents ($n = 8$) from the LinkedIn search pool ($N = 40$) as previously described. This low sample size makes it difficult to construct a survey population that mirrors the region's data analyst composition at a significant level of confidence. Also, research indicates there is another concern when it comes to this kind of self-reported data. Even as respondents believe they are being accurate, we can only collect information on what their perceptions are. Participants may often respond in a way that they think the researcher wants to hear and provide answers that is not contradictory to the perceived goal of the researcher (Fraenkel, Wallen, & Hyun, 2012). It is recommended that careful consideration is given before making statistical inferences based upon the findings and conclusions of this report.

Labor Market Assessment Results

In order to develop a general sense of the data analytics field in the local area, participants were asked about hiring and demand specific to their organization. A majority of respondents were confident that the demand for data analytics workers would increase over the next five years, with 50.0% anticipating the need to significantly increase, and 37.5% expecting a slight increase. Similarly, 75.0% of surveyed professionals anticipated that their organization would more than likely be investing in data analytics initiatives during this time. The remaining 25.0% responded as unsure, while no one indicated that they expected no investments at all. And while there is a common feeling that the need for workers skilled in data analytics will rise to meet the needs of industry, 75% indicated that it has been “challenging” for their organization to recruit for or fill positions requiring data science skills, with an additional 12.5% indicating that it has been “very challenging”. Only 12.5% indicated that their organization has not had a significant challenge recruiting for these positions.

Skills Need Assessment Results

In order to identify the relevant skills and technologies that are being utilized by data analysts across local industry, respondents were asked to describe how often they rely on and utilize specific technologies in their work. These results are shown in Table 9. And to obtain further information on what technologies and skills should be considered for academic programs in data analytics, participants were also asked to rank the importance of each technology to an undergraduate academic program. These results are shown in Table 10.

Table 9 Frequency of Use of Technology Skills

Technology Skill	Frequently	Occasionally	Never
SQL	87.5%	12.5%	0.0%
Excel	87.5%	12.5%	0.0%
R	50.0%	25.0%	25.0%
SAS	57.2%	0.0%	42.8%
Python	12.5%	50.0%	37.5%
Hadoop	14.3%	14.3%	71.4%
SPSS	0.0%	28.6%	71.4%
MapReduce	0.0%	42.9%	57.1%
Java	0.0%	28.6%	71.4%
JMP	0.0%	14.3%	85.7%
Hive/Pig	0.0%	14.3%	85.7%
NoSql	0.0%	0.0%	100.0%

Table 10 Academic Importance of Technology Skills

Technology Skill	Very Important	Somewhat Important	Not Important	Not Sure
SQL	62.5%	37.5%	0.0%	0.0%
Excel	62.5%	12.5%	25.0%	0.0%
R	65.2%	37.5%	0.0%	0.0%
SAS	25.0%	50.0%	0.0%	25.0%
Python	71.4%	14.3%	0.0%	14.3%
Hadoop	33.3%	50.0%	0.0%	16.7%
SPSS	0.0%	14.3%	57.1%	28.6%
MapReduce	14.3%	57.1%	0.0%	28.6%
Java	14.3%	28.6%	28.6%	28.6%
JMP	0.0%	16.7%	33.3%	50.0%
Hive/Pig	0.0%	33.3%	16.7%	50%
NoSql	0.0%	50.0%	16.7%	33.3%

In order to explore the feasibility of offering a data analytics degree at the associate level as opposed to the traditional bachelor's or graduate degree, participants were asked if they would consider hiring someone who recently completed an associate degree in data analytics. Of these responses, 12.5% stated that they would absolutely consider hiring someone with an A.A.S. degree, while the remaining professionals (87.5%) replied that they would consider such a graduate, depending on their work history and/or completed coursework. Importantly, no one indicated that they would refuse to consider a graduate who only had an associate level degree in data analytics.

Interviews

In addition to the survey responses, interviews were conducted with three individuals working as data scientists and analysts in the local region. Similar to surveys, interviews are an indirect measure used to obtain qualitative data where respondents are reflecting on knowledge or learning, rather than demonstrating it (Stassen, Doherty, & Poe, 2001). Each interview was conducted as a semi-structured interview. With this method, the same questions are asked of all respondents, but the interview is more conversational and the interviewer has the freedom to rearrange or rephrase the questions (Ary, Jacobs, & Sorensen, 2010). The interviews were conducted between August 1, 2017 and August 15, 2017. The interviewees ($n=3$) represented various key administrative, operational, and technical levels in their respective organization. Interviews lasted between 30 minutes and 45 minutes and were conducted via face-to-face and phone. Interviews focused on issues such as current and projected hiring needs for data scientists and labor market needs and

challenges. For a complete list of study contributors, please see the Appendix.

Through these interviews, there were several key items of relevance to be considered for the development of a data analytics program.

Though it is not necessarily required, few organizations currently staff data analysts with less than a bachelor's degree. However, while this has been current practice in the past, organizations may not be opposed to hiring individuals with an associate degree if they can demonstrate proven technical abilities. In fact, it appears that many organizations are hiring people with data analytics skill who have bachelor's degrees in unrelated fields, but who have been successful through self-education and experience.

“As of now, everyone here working in a data science capacity has at least a bachelor's degree. But more often than not, not even in a data science discipline. But they have the background to adapt well.” (Interviewee A)

“Well, we probably don't have anyone here with just an associate's degree in data analytics, because there aren't really many associate's programs yet that I'm aware of.” (Interviewee B)

“While I have a bachelor's degree, it's in finance. I've just learned data science along the way. But in looking at the courses that could be taken in a two-year program, a community college student could have a lot more analytics skills and experience than I got with my bachelor's.” (Interviewee A)

“I'd say that the idea of a capstone project or course would be critical to this program. If a student will only earn a two-year degree, they'd need to show some concrete evidence that they've mastered the necessary skills and programs and can effectively explain their results.” (Interviewee B)

“As long as a student can demonstrate their skills, I absolutely think they can get a job with less than a bachelor’s degree.” (Interviewee C)

Although technical skills are important, employers are emphasizing the need for critical skills in communication and business. If an applicant has less than a bachelor’s degree in data analytics, they are much more likely to be hired if they possess strong interpersonal skills, such as communication, teamwork, leadership, and motivation.

“To be honest, the problem we have with our new hires is not that they can’t handle the programming or technology, but they struggle to communicate results.” (Interviewee A)

“At the end of the day, what really matters is if you can effectively manipulate the data and share these results in the context of whatever project you’re working on, not so much as to what the specific academic degree is.” (Interviewee B)

“...actually, I spend the majority of my time presenting my results or meeting with teams to identify what their problems or needs are.” (Interviewee A)

While there is no consensus on everything that needs to be included in a data analytics curriculum, there are reliable skills and tools to include. As data analytics is still such a new and emerging field, and various industries are using it in different contexts to meet their needs, it is not always clear as to what skills are critical. However, by exploring what is being used most often and what lends itself to industry convention, trends can be observed to help develop a more informed curriculum.

“The most important tools for industry preparation are R, Python, and SQL, especially [as these are] open source. SAS is great for academics, but businesses don’t always want [to pay the cost of] licensing...If you want to prepare students for a good job, stick with the open source resources.” (Interviewee B)

“Learning basic statistics is one of the most important things...You can learn R and Python, but if you don’t know the statistics behind it, then there’s no point.” (Interviewee C)

“A solid understanding of Statistics is necessary for R, and I’d say that discrete math is necessary for SQL.” (Interviewee B)

“I don’t have a strong academic background in math, or even statistics, but I’ve learned how to manipulate and present data using the necessary software.” (Interviewee A)

“Yeah, machine learning is definitely a hot, new topic in data science, but I think that requires a more advanced skillset...I don’t think that could be covered in a two-year program.” (Interviewee C)

“Tableau is the best tool for data visualization. It’s something that I use every week at my job.” (Interviewee A)

“Tableau is useless. The same things can be done with Excel, or R. Just stick with Excel.” (Interviewee B)

“I use SAS for pretty much everything. But I think I’m also the only person at work that uses it. Maybe that’s because I used it so much in grad school though.” (Interviewee C)

Key Findings and Recommendations

The recommendations below are listed so as to correspond to the research described above and can be generalized into two broad objectives:

- Closing the gap in the projected industry demand

- Developing a quality and efficient educational programs to satisfy employer needs.

Recommendations 1 and 2 aim to help Delaware Technical Community College to increase enrollment in the data analytics program examined in this study and raise awareness of the educational and career pipeline opportunities available in this field. Recommendations 3 through 6 seek to help DTCC develop quality data analytics programming so as to better meet the skill needs of local employers while ensuring that graduates are entering the workforce ready and able to succeed in today's competitive job market.

1. **Organizations have high growth expectations for data analytics within the next five years.** This presents a unique opportunity for Delaware Tech to develop a program that will satisfy the needs of local industry while following the Strategic Goals of the college. Evidence of this growth should continue to be researched and documented by the college to help market this new program to potential students while also selling the effectiveness of the program to local industry.
2. **Work toward developing articulation agreements and certificate options.** In order to increase potential student enrollment, it will be beneficial to offer additional pathways. By offering certificate options, DTCC can recruit working professionals who may already have a degree, but are interested in advancing their career through improved knowledge and skills. Additionally, many students may want to eventually continue on to a bachelor's degree in data analytics, so offering a pathway for transfer could increase enrollment

while allowing students to also pursue high-order skills to satisfy industry need. This pathway is seen in many other programs at Delaware Tech where students would prefer to start their undergraduate degree at a more affordable option such as a community college.

3. **Focus credit coursework on a well balanced mix of mathematics, business, and data science.** Explore having students learn the field by working with established and practical technologies such as R, Python, and Excel. Also, faculty should be encouraged to include project-based learning often throughout the program so students are comfortable applying authentic aspects of data analytics. It is recommended that the college research the feasibility and efficiency of utilizing other technologies that may require licensing fees.
4. **Focus on professional and career navigation skills, with an emphasis on communication and problem solving.** Professionals in the data science field commented on the importance and shortage of these skills, specifically in the context of what data scientists are often required to do on a regular basis. This new program could benefit from an enhanced curriculum focused on long-term career skills such as teamwork, communications, analytical problem solving, etc. This can be accomplished through exercises or group projects that focus on developing a student's professionalism, confidence, and business skills. Additionally, the college should provide a well-rounded core curriculum including relevant courses in English, communications, ethics, and business.

This will help enable program graduates to better facilitate professional relationships and strengthen business opportunities for their employer.

5. **Incorporate capstone and/or internship models in the program.** As data analytics is an applied discipline, it is critical that graduates enter the workforce with the ability to prove their capabilities. Being able to demonstrate their mastery of skills through a professional and authentic capstone project and portfolio will be the critical component of allowing employers to look past the idea of requiring a bachelor's degree to consider a well-qualified graduate of this associate degree program in data analytics. This requires leveraging and expanding relationships with participating local industry, many of whom were identified in the research.
6. **Finally, this report generalizes the labor market for select organizations, across specific skills sets.** It may be beneficial to further examine labor market information in more detail at the skill and organizational levels as a follow up to this report. This could be accomplished through open dialogue and the sharing of information with other relevant academic institutions with similar goals in the data analytics field. Also, occupations represented by the various skill sets could be tracked over time to monitor for changing requirements regarding education and experience, as well as the changing needs of specific employers.

Conclusion

Through a variety of measures, it is evident that data analytics is a high-growth field both at the national and regional levels. While these fields traditionally tend to favor individuals with graduate or bachelor level degrees, it is becoming more likely that there will be significant opportunities for those who may have less than a bachelor's degree. Graduates who have completed a well-rounded associate degree, earned industry certifications, and have collaborated on an authentic capstone project should be able to demonstrate the necessary knowledge, skills, and abilities to be successful in a variety of positions within data analytics. Delaware Technical Community College has the chance to provide this opportunity to motivated Delawareans looking to enter the emerging and exciting field of data analytics.

References

- AnalyticsWeek. *Investigating data science skills*. (2015, September 23). Retrieved August 15, 2017, from <https://analyticsweek.com/content/investigating-data-scientists-their-skills-and-team-makeup/>
- Ary, D., Jacobs, L., & Sorensen, C. (2010). *Introduction to Research in Education*. Belmont: Wadsworth.
- BHEF. (2017). *Investing in American's data science and analytics talent*. Business Higher Education Forum. Retrieved August 15, 2017, from <https://www.pwc.com/us/en/publications/data-science-and-analytics-skills.html>
- Cárdenas-Navia, I., & Fitzgerald, B. K. (2015). The Broad Application of Data Science and Analytics: Essential Tools for the Liberal Arts Graduate. *Change: The Magazine of Higher Learning*, 47(4), 25–32.
- Cegielski, C. G., & Jones-Farmer, L. A. (2016). Knowledge, Skills, and Abilities for Entry-Level Business Analytics Positions: A Multi-Method Study. *Decision Sciences Journal of Innovative Education*, 14(1), 91–118.
- Dumbill, E., Liddy, E. D., Stanton, J., Mueller, K., & Farnham, S. (2013). Educating the Next Generation of Data Scientists. *Big Data*, 1(1), 21–27.
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. . (2012). *How to Design and Evaluate Research in Education*. New York: McGraw Hill.
- SHRM. (2016). *Jobs of the Future : Data Analysis Skills Table of Contents*. Society for Human Resource Management.
- Smucker, B. J., & Bailer, A. J. (2015). Beyond Normal: Preparing Undergraduates for the Work Force in a Statistical Consulting Capstone. *The American Statistician*, 69(4), 300–306.

Stassen, M., Doherty, K., & Poe, M., (2001). Program-Based Review and Assessment: Tools and Techniques for Program Improvement. *Office of Academic Planning and Assessment*. Amherst.

Appendix – Survey and Interview Participants

I would like to recognize and thank the following participants and companies for their contributions to this workforce research and their commitment to helping Delaware Technical Community College to connect Delawareans to jobs within the region. All interviewees also participated in the survey.

Survey Participants

Business / Organization	Participant Job Title	City, State
QuintileIMS	Data Engineer	Wilmington, DE
Agilent	Data Analyst	Wilmington, DE
LexisNexis	Lead Operations Mgr.	King of Prussia, PA
Board of Internal Medicine	Statistical Research Assoc.	Philadelphia, PA
Comcast	Director of Data Analytics	Philadelphia, PA
Velotio Technologies	Data Scientist	Newark, DE
Christiana Care	Data Scientist	Newark, DE
Capital One	Director of Data Science	Wilmington, DE

Interview Participants

Identification	Date
Interviewee A	August 11, 2017
Interviewee B	August 14, 2017
Interviewee C	August 5, 2017

Appendix C

SURVEY AND INTERVIEW PROTOCOL

Initial Contact Script

Brad Thompson, a doctoral student at the University of Delaware, is conducting a feasibility study on the development and implementation of an associate level degree in the field of data science and analytics. You are requested to participate in a confidential interview about what skills, knowledge, and attributes your organization looks for in candidates applying for positions related to data science, as well as what degree requirements may be considered. The interview should take 5-15 minutes and would occur via telephone.

Summary and thematic reports will be generated based on the information collected that may help guide the development of a new associate level program in data science and analytics. The report will be shared with Mr. Thompson's doctoral committee.

There are no risks to your participation. Participation is entirely voluntary, but your perspectives would be greatly appreciated.

Please rest assured that all responses are confidential. You will not be asked for any personally identifying information and none of your responses will be associated with you personally. Any responses taken from these surveys will only be reported in aggregate form. There are no consequences if you choose not to participate.

If you have any questions concerning the survey, please contact Brad Thompson (bthompso@udel.edu).

If you agree to participate in this interview, please kindly reply to this email and I will set up a time that works with your schedule to speak via phone. Thank you in advance for your assistance.

Survey Questions

- 1) What is your name? (optional)
- 2) What is your job title? (optional)
- 3) What is the name of your organization/company? (optional)
- 4) How challenging has it been for your organization to recruit for positions requiring data analytics skills?
- 5) Does your organization receive a significant number of applications for data analytics positions from outside of the local region?
- 6) How would you expect the demand for workers skilled in data analytics to grow over the next five years?
- 7) If you are aware, do you anticipate your company to make any investments in data science and big data initiatives?
- 8) How often do you utilize each of the following technologies in your work?
- 9) In your opinion, what are the most critical skills for an undergraduate data science student to master before graduation?
- 10) Are there other technologies included in the previous list that you think are critical for future data scientists?
- 11) Would you consider hiring someone who recently completed an associate level degree program in data science?

Interview Script

First, I will introduce myself, and describe the purpose of the project. I will inform the interviewee that they have been selected to participate because their organization may employ, or be hiring employees to work in fields where data science skills and education are needed. There will be a brief discussion to clarify terminology

for the interview regarding. For the purposes of our discussion, the terms “data science”, “data analytics”, and “business analytics” can be used interchangeably. The interview will begin and interviewees will be asked the following questions. After which they will be thanked for their time and offered the opportunity to ask any questions of their own relevant to our discussion.

1. Is it fair to say that your organization is primarily involved in the field of _____? (I will suggest the logical sector based on what organization I was interviewing, be it education, finance, government, health services, information technology, etc.)
2. Approximately, how many positions for dedicated data scientists/analysts or requiring data science skills and knowledge?
3. Would you say that it has been easy, average, or challenging for your organization to effectively recruit successful data science candidates for these positions? And are you receiving a significant proportion of applicants that are located outside of our local region (Delaware, Southern New Jersey, Eastern Maryland, Southeast Pennsylvania)?
4. Would you anticipate that over the next five years, demand for data analytics professionals within your organization will decrease, remain steady, or grow? And if you expect growth, do you anticipate what could be considered rapid growth?
5. If you are aware, do you anticipate that your organization will be making additional investments in big data initiatives within the next five years?
6. When posting positions for data analysts, what are the most important technical knowledge, skills, and abilities that are listed as required? For example, are you looking for candidates skilled in R, Python, SQL, SPSS, Hadoop, other?
7. And what about general and analytical skills? Is your organization emphasizing importance on having experience with data visualization, predictive analysis, machine learning, project management, other?

8. When searching for candidates, does your organization list a specific degree (Bachelor's, Master's, Ph.D.) as a minimum requirement to apply?
9. Concerning the current positions related to data analytics at your organization, would you say that there are varying levels? For example, are there entry-level, mid-level management, and/or director level positions where data science skills and abilities are required?
10. Would you consider hiring a graduate of a new associates degree program in data science if they were able to demonstrate competency and experience in the skills and abilities required by your organization? Could you please elaborate on your answer?
11. If a new associate level data science degree was locally developed and offered to support the needs of local industry and workforce, do you think your organization could potentially be interested in creating a working partnership with this program? For example, through offering internship opportunities, working with students on real-world data problems, having representatives present at program workshops or speaker series, etc.

IRB Approval



RESEARCH OFFICE

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DATE: May 25, 2017

TO: Lauren Bailes
FROM: University of Delaware IRB

STUDY TITLE: [1068903-1] Feasibility Study for an Associate Degree in Data Science Brad Thompson - Ed. D. ELP

IRB REFERENCE #:
SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE: May 25, 2017

REVIEW CATEGORY: Exemption category # (2)

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office. Please remember to notify us if you make any substantial changes to the project.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.

Appendix D

THE BUSINESS ANALYTICS A.A.S. DEGREE AT WAKE TECH COMMUNITY COLLEGE: A CASE STUDY OF A PIONEERING PROGRAM IN DATA SCIENCE AND ANALYTICS

Introduction

Wake Technical Community College (WTCC) is a two-year public community college serving residents of Wake County, North Carolina, which is home to more than 900,000 residents. As the largest community college in North Carolina, it serves more than 71,000 students annually across five campuses. The institution offers more than 200 associate degrees, diplomas, and certificates to prepare students for employment or university transfer. Wake Tech also offers non-credit workforce training and business support, as well as basic skills (including high school equivalency preparation). Wake Tech's mission is to improve and enrich people's lives by meeting the lifelong education, training, and workforce development needs of the community.

In February 2012, Wake Tech proposed a new Associate Degree in Business Analytics (A.A.S.) program to the North Carolina Community College System and the Southern Association of Colleges and Schools. And although the courses had not yet been developed at this time, approval was granted from both organizations. It was in October 2012 that Wake Tech received grant funding from the Department of Labor (DOL), which allowed them to target key populations while accelerating the development of the new Business Analytics associates degree program (BAS). In developing this pioneering program, Wake Tech sought to prepare students for the anticipated in-demand analytics jobs of the future and was able to create the first data analytics associates degree in the United States.

The Business Analytics program provides stacked and latticed credentials by offering students the options of preparing for two analytics certificates, gaining an AAS Degree in Business Analytics, and/or transferring to a four-year degree program in applied science, business, or statistics. The accelerated business analytics program option is available for persons with entry to mid-level skills and some college training who may want to quickly gain skills that lead to industry certificates and prepare them to sit for certification exams.

Purpose of Study

As the goal of this program proposal is to create a new Data Analytics Associate Degree at Delaware Technical Community College, it is important to look at the challenges and successes of other institutions who have gone through a similar process. In an attempt to meet industry needs, data analytics programs are on the rise at institutions of higher education across the country to close the growing skills gap. But the overwhelming majority of these programs are at the bachelors or graduate levels. So while offering such a new and cutting edge program at the community college level at this point presents an exciting and unique opportunity, there will also be challenges that are unique to developing and delivering such a program. For this reason, it is critical to examine not only other institutions who are now creating data analytics programs, but specifically at other community colleges. As mentioned previously, Wake Tech Community College is currently the only such institution and has only recently began offering their program. And while this may prove to be a limitation when it comes to finding data related to student and program outcomes, Wake Tech's experiences in rolling out their program from the ground up can prove valuable to the development of a similar program at Delaware Technical Community

College. It is also important to note that while the program at Wake Tech Community College is called “business analytics”, and the proposed program at Delaware Technical Community college is being referred to as “data analytics”, there will most likely be few differences between the program objectives and curriculum goals of the two programs. This is due primarily to preference, as well as the fact that there is still little consensus as to the specific variance in definitions of business analytics, data analytics, and data science.

Research Questions

The key program implementation and outcome questions of the study were:

1. How was the WTCC Business Analytics program designed, developed, and delivered since its original proposal?
2. To what extent has the program been effective in producing the desired student outcomes with regard to completion, placement, other?
3. What were the key challenges in the development and administration of the program and how has the program since addressed those challenges??

Case Study Methodology

The research approach of this study is based on the major questions presented above. This case study documents the design, development, and implementation of the Business Analytics degree program at Wake Tech Community College. A mixed methods approach of data collection was utilized to ensure triangulation of results.

Data Collection Methods

- Individual, face-to-face, and telephone interviews with Program Director, Tonya Scott.

- Email correspondence with Program Director and BAS staff.
- Review and observations of student profiles, feedback, and capstone projects.
- Observation of in-person and webinar presentations by Wake Tech BAS faculty.
- Observation of three industry WTCC BAS Speaker Series presenters.
- Gathering descriptive student enrollment data through the Program Director.
- Document and website reviews.

Documents and Websites Reviewed

- Wake Tech Community College website, www.waketech.edu
- Business Analytics, Wake Tech 2016-2017 Catalog
- Business Analytics Program Brochure
- Business Analytics Program Planning Guide
- Syllabi for all courses in Business Analytics curriculum
- Business Analytics curriculum program outcomes
- WTCC student data analysis reports
- News in Education (NiE) BAS Program infographic
- WTCC BAS Department of Labor proposal

Presentations Reviewed

- Developing Analytics for the Community College. Tonya Scott, Project Director of Business Analytics Department and Walter Martin, Dean of Business and Public Services Technologies Division American Mathematics Association of Two-Year Colleges (AMATYC), Speaker Series 2015.
- Building a Business Analytics Program. Tonya Scott, Project Director of Business Analytics Department and Walter Martin, Dean of Business and Public Services Technologies Division Hi-TEC Portland Conference, 2015.
- BAS Information Session, Tonya Scott, Project Director of Business Analytics Department. Delaware Technical Community College, 2016.
- Developing Business Analytics. Tonya Scott, Project Director of Business Analytics Department. Achieving the Dream Data and Analytics Summit, 2016.
- Industry and Educational Trends and Insights in Data Analytics. Tonya Scott, Project Director of Business Analytics Department and Walter Martin, Dean of

Business and Public Services Technologies Division. National Business Education Association Conference, 2016.

- Protecting Data. Kathy Hart, Data Scientist, SAS. Wake Tech Business Analytics Fall Speaker Series, 2015
- Presenting Careers in Business Analytics-Technologies. Jim Barnes, Director of Technology Solutions, Asponde Technology. Wake Tech Business Analytics Spring Speaker Series, 2015
- Presenting Careers in Business Analytics. Jacob Anderson, Business Intelligence Developer, Business Impact. Wake Tech Business Analytics Spring Speaker Series, 2015

Program Description

The Business Analytics curriculum is designed to provide students with the knowledge and the skills necessary for employment and growth in analytical professions. Business Analysts process and analyze essential information about business operations and also assimilate data for forecasting purposes. Throughout the curriculum, students engage with the latest tools and technology utilized in today's analytics fields and focus on developing new insights and understanding business performance using data and statistical methods.

The WTCC Business Analytics Associate Degree requires 65 semester credits, including eight BAS courses and other electives in computer science, logistics, mathematics, English, business, and humanities. All courses are offered at WTCC. It includes two stacked certificate programs that allow students to gain industry certification from SAS, either in Business Intelligence or Business Analytics:

1. BAS Certificate 1 includes the first four BAS courses and qualifies students to take the Base SAS Programmer certification exam.
2. BAS Certificate 2 includes the remaining four BAS courses and qualifies students to take the SAS statistical business analyst certification exam.

In selecting their electives, students have the option of selecting one of four tracks; Financial Analytics; Marketing Analytics; Logistics Analytics; and Web Technology/Analytics. These focused specialties were selected based on the areas of highest demand in the analytics field. According to recent interviews with BAS faculty, the four certificates are very popular with students who are already employed, because it allows them to build their existing skill sets. These are designed in to be either “stacked” or “latticed”. Stacked courses allow students to complete each certificate program separately in a short period of time (e.g., two semesters). The latticed certificate options encourage students to take additional courses so they can earn several certificates simultaneously. In general, students need to complete four courses to earn a certificate. This approach has proven to be effective as many students may require eight semesters to complete the program, rather than four semesters, and gaining certificates along the way allows them to experience interval successes to continue motivation.

Program Curriculum Development

Wake Tech’s Business Analytics curriculum was conceived and designed primarily to address the increasing need for a workforce knowledgeable in data analytics to meet the needs of local industry. By the time Wake Tech received notification of grant funding from Department of Labor, it had already completed much of the design of the curriculum during the prior year. Two administrators and two faculty members from the Business and Public Services Technologies Division collaborated in mapping the academic plan for the program. This involved identifying

the courses to be developed and the prerequisites, writing course descriptions and sequences, and developing the two-year degree plan.

To identify the necessary requisite skills and curriculum, faculty consulted industry professionals and reviewed the undergraduate and graduate-level courses offered at North Carolina State University (NCSU). The program designers held a curriculum design workshop to identify the required competencies. After inviting all community colleges in North Carolina to attend a workshop to discuss program design, representatives of four community colleges (Durham Technical Community College, Central Piedmont Community College, Forsyth Community College, and Guilford Community College) and representatives from the North Carolina Community Colleges System Office (NCCCSO) attended the meeting in October 2011.

Wake Tech also conducted a job market/industry survey via e-mail in August 2011 to over 600 relevant and local industries. The goal of this survey was to further identify key program competencies while gauging industry opinion on the feasibility and marketability of such a program. While the survey response rate was very low (17/600 or 2.8%), industry respondents overwhelmingly supported the creation of the BAS analytics program.

The overall program design also incorporated:

- Strategic partnerships with industry leaders in information technology and analytics (e.g., SAS, IBM, RTI, Keshav Consulting), education partners (e.g., William Peace University, and Campbell University), and other crucial partners (Capital Area Workforce Development Board).

- Partner, analytics experts, and employer involvement in DACUM (Developing a Curriculum) and Delphi processes to ensure the program's eight new BAS courses meet current and future training needs.
- Use of instructional design personnel and instructors who are knowledgeable in the relevant subject areas and with effective instructional approaches for both traditional and distance education course formats.
- Inclusion of support personnel to aid in recruiting and retaining students as well as forming necessary relationships with employers to provide opportunities for job shadowing, internships, and other learning experiences.
- Availability of a cloud-computing platform that allows students to perform all required coursework online regardless of their physical locations from any computer with Internet access.

Throughout the process of designing and developing the Business Analytics associate degree program, business and industry partners played an invaluable role in providing critical information. They have provided input on current and future job demands, developing standards and competencies through the curriculum design process, and identifying the analytical, business, and other skills needed to be successful in the workplace. They also provided guidance on secondary knowledge requirements such as mathematics, finance, marketing, business, and expectations of performance and software experience.

During this process, Wake Tech worked most closely with the statistical software company SAS, who is an industry leader in the field of statistical analysis software and systems. This was because SAS offered the use of their software and

access to the design of their certification programs with the goal of preparing BAS students for valuable SAS certifications. Also, it was extremely beneficial that the global headquarters of SAS is less than twenty miles from Wake Tech, and they have had additional partnerships on various projects in the past. SAS is powerful analytics software, used by more than 90% of fortune 500 companies, and has detailed documentation, supplementary textbooks with excellent technical support. Additionally, learning SAS software provides the necessary foundation for using other statistical software packages, most of which do not have the same level of support as SAS for use in the classroom. In developing the course content, the design team was fortunate to have access to both the existing SAS curriculum and free use of software, as well as existing graduate level analytics resources. In fact, during the development process, the BAS faculty worked under the mindset of developing the program according to a master's programs in analytics, but without expecting the students to perform at a graduate level. This partnership proved to be a huge asset in both the development, and continued success of the program.

From these industry partnerships, and research conducted on existing analytics academic programs at various levels, it was necessary to determine what would be the relevant and marketable technology skills for graduates to have. Throughout the program, students are introduced to general analytics skills such as utilizing statistical programming tools to conduct descriptive analytics, building and validating predictive models for classification and regression tasks, and analyzing complex data, including semi-structured and unstructured data, using analytical tools and methods. This is done by working with relevant and marketable technologies including Alteryx, Tableau, SAS, R, and Python. The program also encourages the mastery of various skills

needed for success in the business industry. These include the ability to communicate the problem, process, and final results orally and in written format appropriate to the receiving audience; collaboration; lifelong learning; driven, persistent, and problem solving attitude; strong ethical base and professional integrity; and business acumen.

The Business Analytics program is structured as a four semester curriculum that also provides stacked and latticed credentials offering students the options of preparing for two analytics certificates (Business Intelligence or Business Analyst) that can be completed in two semesters on the way to completing the A.A.S. degree. The courses required to prepare for taking the two certification examinations are shown in Table 11, while a complete listing of courses in the BAS curriculum is found in the Appendix.

Table 11 Certificate Requirements

<i>Certificate</i>	<i>Course Number/Title</i>	<i>Credit Hours</i>
Business Intelligence	BAS 120 Business Analytics I	3
	BAS 121 Analytics Methods I	3
	BAS 220 Business Analytics II	3
	BAS 150 Analytics Tools I	3
Business Analyst	BAS 221 Analytics Methods II	3
	BAS 230 Business Analytics III	3
	BAS 250 Analytics Tools II	3
	BAS 270 Analytics Practicum	3

Upon completion of the required courses for the Business Intelligence Certificate, students can attempt the Base SAS Programmer Industry Certification exam and upon completion of the required courses for the Business Analyst

Certificate, students can take the SAS Statistical Business Analyst Certification exam. This information is presented to students through advisement in the form of a program planning guide, which can be found in the Appendix. In addition to the two Business Analytics certificates, students also have the option of gaining certificates in Marketing Analytics, Logistics Analytics, Finance Analytics, and Database Analytics. These are managed by other Wake Tech departments, but utilize many skills found in the BAS program and can be valuable additions to the resume of all WTCC students.

Program Management

In July 2013, Wake Tech invited industry partners attending the Triangle Area Analytics Group (TAAG) to sit on the Wake Tech Business Analytics Advisory Board. The Board met for the first time on August 29, 2013, and included five respected individuals and representatives of local industry. Advisory Board members were not involved in the design and development of the BAS program but did provide feedback after its inception on such factors as existing course quality, the curriculum, and the overall direction of the program. Advisory Board members identified several possible challenges for the development and management of the programs. These included covering the breadth of required information in a program designed to be two years, as well as recruiting qualified and dedicated instructors. A major concern was that the number of topics and disciplines that the curriculum needs to cover presents a significant challenge to program design. But while they acknowledged this challenge, they also knew that the benefits of the program would outweigh this, and this challenge could be overcome through creative and informed design. A significant breakthrough for the group occurred when they proposed that the challenge of curriculum coverage is best addressed by moving ahead with the design and delivery

of the A.A.S. program, and allowing it to evolve as need be depending on needs, feedback, and further research. The involvement of an Advisory Board that is comprised of professionals employed in business analytics settings proved to be of great value to the program as it was implemented and as the curriculum continues to be further developed.

Faculty and Staff Recruitment

Early in the program planning process, the Program Director assumed responsibility for identifying the faculty and staff needed to implement the new program. A key focus was on hiring an instructional designer experienced in developing curriculum as well as recruiting faculty members who were knowledgeable about business analytics, had professional and authentic experience in the industry, and were capable of employing instructional best practices. The following criteria were used when recruiting BAS instructors:

- an earned master's degree,
- a strong mathematics background,
- experience in using statistical packages (either SAS or SPSS), and
- a strong understanding of analytics.

According to the Program Director, identifying and approving instructors for the BAS program was, and continues to be, a major challenge. The program is new and many applicants did not have a clear understanding of the responsibilities involved, nor of the course content. The two initial instructors for the program were recruited from within Wake Tech. The other initial staffing needs were for an instructional designer to help design the curriculum, and the industry liaison and student recruitment coordinator to help promote the program. Wake Tech

administrators noted it was challenging to find the right candidates for these positions because the BAS program was new and because the salaries were not commensurate with the talent needed. Despite delays in filling some positions, all necessary personnel for the initial launch were in place by the summer of 2013, prior to the official launch of the program in Fall 2013.

As the program continues to grow, securing an adequate supply of qualified instructors has continued to be a major issue facing the BAS program. During this past year, it became necessary for the Program Director to step in and teach courses until new faculty could be recruited and trained. One reason for this challenge is that the industry of business and data analytics is thriving, so there is not much of a need for these professionals to take on the stresses of teaching for a comparatively modest salary.

Student Recruitment and Demographics

From the beginning of the Business Analytics program, both Wake Tech and the program itself advertised through a variety of modes, including: local radio stations; local newspapers; marketing publications; WTCC's website; and social media. The BAS program also hosted open house sessions on campus where an Industry Liaison and Student Recruitment Coordinator set up recruiting booths for attendees. A main focus of the Student Recruitment Coordinator focuses on reaching high school students. One of the major challenges is that all departments at WTCC recruit students from the same high schools. Hence, the Business Analytics program is essentially competing with other departments. Based on previous experience, one recruitment strategy was to target schools that have a reputation for high achieving math and IT groups within their student body. The Student Recruitment Coordinator

also recruits students who are enrolled in Business Administration courses at Wake Tech. Typically, students who are interested in mathematics or statistics tend to do well in BAS courses, so the coordinator makes an effort to reach out to students whose interests lie in these areas.

Over the past two years, the Business Analytics program has continued to grow. Total enrollment has increased from 13 students in the Spring of 2013, to 165 students in Fall 2014, to more than 500 in the Fall of 2016. Demographic data from 2016 – 2017 shows that nearly half of current BAS students are mid-career professionals aiming to expand their skillset and make themselves more marketable to employers, while just over 33% were unemployed at the time of enrollment. Many students have previous college experience or already have a bachelor's degree, with only a relative few recent high school graduates enrolling in the program. This is also evident in the age of the BAS students as only 6% are under the age of 21 years, 37% are between 21 – 32, with the remaining 57% of students over the age of 32 years old. An interesting aspect of this program is that it has attracted a significant proportion of students who have long been considered “non-traditional” in the academic fields of mathematics, statistics, and computer science. Over 48% of students in the program identify as female, with 42% reporting as African American, Hispanic, or more than one race. Table 12 provides additional information regarding BAS student demographics.

Table 12 WTCC BAS Student Demographics, 2015-2016

	<i>Frequency</i>	<i>Percentage</i>
Sex		
Female	145	48.7%
Male	144	48.3%
Ethnicity		
American Indian/Alaskan Native	1	.3%
Asian or Pacific Islander	30	10.1%
Black and African American	58	19.5%
Hispanic	11	3.7%
White, non-Hispanic	169	56.6%
Multiple, Unknown	20	6.7%
Work Status		
Full-time	167	56.0%
Part-time	20	6.7%
Unemployed and seeking	81	27.2%
Unemployed but not seeking	19	6.4%
Retired	2	.7%

Student Outcomes

While Wake Tech's BAS program has just recently begun graduating students, there has been some promising initial data regarding student outcomes and feedback of the program. During the 2013-2014 school year, there were 20 students earning certificates. This increased to 65 students earning certificates during 2014-2015 (mostly in Business Intelligence). Table 3 shows the program and course completions through the Spring 2016 semester.

Table 13 BAS Course and Program Completions

	<i>Frequency</i>
Courses completed	
BAS 120	251
BAS 121	147
BAS 220	91
BAS 150	74
BAS 221	27
BAS 230	18
BAS 250	9
BAS 270	9
Certificate or degree earned	
Business Intelligence Cert.	74
Business Analyst Cert.	4
Finance Analytics Cert.	2
Logistics Analytics Cert.	3
Marketing Analytics Cert.	7
Database Analytics Cert.	3
Business Analytics A.A.S. Degree	4

Across the BAS courses, grade distributions have been positively skewed, with the majority of students earning A's and B's, with few students failing to successfully complete the courses. According to what faculty and staff have reported to the Program Director, most attrition occurs in the introductory classes, with a 15-18% withdrawal rate, whereas there have been few withdrawals from the advanced BAS courses. The trend appears to be that once a student has completed BAS 150, they are typically successful in completing a program (either certificate or degree). The Business Analytics program leaders look forward to the continued analysis of student outcome data as the program continues. The results from these analyses will be applied to future adaptations in curriculum and instruction to improve student success and meet program outcome goals.

Key Challenges of the BAS program

As mentioned previously, this Business Analytics A.A.S. degree program is a pioneering endeavor that had few examples to draw from in the design and delivery of this program. And of the few examples that were available, adaptations needed to be made at nearly every step to meet the unique needs, resources, and restrictions of the institution. Some of the primary challenges that were observed were:

- No other AAS program or similar program by which to benchmark the data analytics program.
- Data Analytics are traditionally offered at the graduate level.
- Employability in a field that typically hires individuals with at least a Bachelor degree, and usually a graduate degree.
- Program is open enrollment and requires few to no prerequisites (other than developmental math and English).
- Accelerated and Online/hybrid instructional delivery is most popular among targeted students.
- Difficult to find qualified faculty (at the WTCC salary range).
- Lack of industry consensus regarding the definition of “analytics”.
- Teaching methodologies, while simultaneously teaching technology tools.

Lessons Learned

Based on the information gained during the case study of WTCC’s BAS program, there are a number of preliminary lessons that would certainly help inform the process of creating a new associates level degree program in analytics. While there will no doubt be additional challenges that are unique to Delaware Technical

Community College, the following lessons should be considered throughout the program proposal, design, development, and delivery:

- Remember that the goal of the program is to have students understand analytics, and not only analytics software tools. As data analytics is such a rapidly developing field with ever changing and improving technologies, it is important to continue refining the program to match the conceptual needs of industry.
- The institution should proactively form partnerships with industry leaders and other academic organizations through the formation of something similar to an advisory board. This will help keep the curriculum relevant and authentic, while also creating opportunities for articulation agreements and real-world analytics experiences through internships.
- Identify and actively recruit instructors with the right skills set and attitude. This may prove to be challenging as professionals with the required skills are often working at salaries above what can be offered by community colleges. But if the faculty and staff are not experienced with the necessary concepts and tools, as well as how they apply to professional situation, the program will not be successful in meeting its goals.
- The program needs to be willing to adapt based on student feedback and trends in the industry. While there will be extensive work done on curriculum and content design at the outset of the program, it is critical that this development does not stop there. There should be ongoing work done between program leaders, faculty, instructional designers, and industry representatives to ensure that the program remains relevant.

- Look for creative ways to provide additional funding opportunities to the program. This could be done through grants from various organizations and should be researched in coordination with DTCC administrators and members of the grant committee. This could help ensure the continuation of the program while also improving the chances of hiring exceptional faculty and staff.

Appendix: WTCC Business Analytics Program Planning Guide

Required Courses						
Course Number		Course Title	Class	Hours Per Week		Credits
				Lab	Clinical	
<u>FIRST SEMESTER</u>						
BAS	120	Introduction to Analytics	2	3	0	3
BAS	150	Analytical Programming	2	3	0	3
BUS	110	Introduction to Business	3	0	0	3
CIS	110	Introduction to Computers	2	2	0	3
ENG	111	Writing and Inquiry	3	0	0	3
MAT	143	Quantitative Literacy	2	2	0	3
<u>SECOND SEMESTER</u>						
BAS	121	Data Visualization	2	3	0	3
BAS	220	Applied Analytical Programming	3	3	0	3
MAT	152	Statistical Methods I	3	2	0	4
BUS	137	Principles of Management	3	0	0	3
—	—	*Elective 1	-	-	-	3
<u>THIRD SEMESTER</u>						
BAS	221	Introduction to Predictive Analytics	2	3	0	3
BAS	240	Data Structures for Analytics	2	3	0	3
ENG	114	Prof Research & Reporting	3	0	0	3
BUS	115	Business Law I	3	0	0	3
—	—	*Elective II	-	-	-	3
<u>FOURTH SEMESTER</u>						
HUM	115	Critical Thinking	3	0	0	3
ECO	251	Principles of Microeconomics	3	0	0	3
BAS	250	Analytical Tools and Methods	2	3	0	3
BAS	270	Advanced Analytical Tools/Methods	2	3	0	3
BAS	230	Applied Predictive Modeling <i>or</i>				
		*Elective III	-	-	-	3

Electives

*Elective 1 (Select 3.0 hours from the following courses)

MKT	120	Principles of Marketing	3	0	0	3
ACC	120	Principles of Financial Acct	3	2	0	4
LOG	110	Introduction to Logistics	3	0	0	3

*Elective II (Select 3.0 hours from the following courses)

MKT	221	Consumer Behavior	3	0	0	3
BUS	225	Business Finance	2	2	0	3
LOG	215	Supply Chain Management	3	0	0	3

*Elective III (Select 3.0 hours from the following courses)

BUS	210	Investment Analysis	3	0	0	3
LOG	225	Logistics Systems	3	2	0	4

Appendix E

WHITE PAPER: DATA ANALYTICS AT DTCC

A White Paper: The Case for Offering an Associate's Degree in Data Analytics at Delaware Tech



“Increasingly, US jobs require data analytics skills. Can we meet the demand? The current shortage of skills in the national job pool demonstrates that business-as-usual strategies won’t satisfy the growing need. If we are to unlock the promise and potential of data and all of the technologies that depend on it, employers and educators will have to transform.”

- *Investing in America’s Data Analytics Talent*
Business Higher Education Forum, April 2017

Introduction to the Field of Data Analytics

Data science and analytics is the science of planning for, acquisition, management, analysis of, and the use of data to make inferences through the creation of data products and analysis. While the term “data science” first appeared in computer science literature in the 1960s, it was not until the late 1990s, that the field began to emerge and separate itself from the statistics and computer science disciplines. The use of more advance computer processing capabilities allowed analysts to deal with much larger data sets and for quicker decision making than in the past. It became necessary to forego the theoretical statistics of the past and implement

computer science techniques to begin coding algorithms to manage, analyze, and predict with data. Data science was first introduced as an independent discipline in 2001, while still incorporating aspects of business, mathematics, statistics, and computer science. The field has since had countless articles, reports, and papers advancing the discipline and has even been declared in the *Harvard Business Review* as the “sexiest” job of the 21st century.

The Impact of a Data Analytics Degree on Delawareans

A Shortage of Graduates with Data Analytics Skills: A 2011 report by the McKinsey Global Institute noted that the data industry is growing at a rate of 40% each year and predicts that by 2018, the United States will face a talent gap of 50-60% relative to supply, as well as a deficit of 1.5 million managers and analysts who can effectively analyze data for purposes of decision making. And while there is extensive research to highlight the need for qualified data scientists at the national level, there is also research that shows a similar need in the local regions served by Delaware Technical Community College. The most recent State of Delaware Labor Market Demand Report released by the Education Advisory Board found that data scientists and business analysts are experiencing high demand with emerging employers, and data science skills make up four of the top five “fastest growing skills” that employers are looking for. Similar trends were also found for the surrounding states of Pennsylvania, Maryland, and New Jersey. Additionally, a similar 2015 study conducted by Burning Glass Labor, in partnership with Delaware Technical & Community College, found over 3,000 online job postings in 13 counties in and around Delaware which advertised data analytics positions.

Delaware Tech's Commitment to Meeting the Needs of Delaware's Industry

An AAS Data Analytics degree fits with the College mission. From the beginning, the community college mission has been to provide open access and prepare graduates for entry-level positions in career fields that meet the community's needs. The specific mission of DTCC is to offer comprehensive educational opportunities that contribute to the economic vitality of the state of Delaware. The institution does this by preparing students with knowledge and skills needed for employment in a competitive workforce across a range of occupational levels. Among the Strategic Directions of the College is the strengthening and developing of programs that demonstrate a strong student-centered focus, expanding and leveraging financial, operational, and partnership resources to meet increased workforce demand, and providing innovative programming that prepares competitive graduates for Delaware's business and industry. Specifically, the College notes that workers will require higher level math skills and more creative mathematical thinking to help companies compete in a global economy, while also meeting the increased demand of professionals with technology skills. The design and implementation of a data analytics program of study embodies this mission because it expands the opportunity of DTCC students within the workforce and simultaneously contributes to Delaware's economic vitality.

A Delaware Tech AAS in Data Analytics means affordable access to a rewarding and well-paying career. Annual tuition and fees at Delaware Tech for the 2015-2016 academic year were \$3,274, the lowest of any institution of higher education (IHE) in the state. Low tuition combined with access to financial aid enables 70% of our graduates to obtain their degree debt-free. Annual tuition and fees at other Delaware Institutions of Higher Education (IHEs) ranged from \$7,336 to \$23,540 a

year. Offering a degree in this highly sought-after field means continued access for Delawareans of all income levels to earn the opportunity for a career with financial stability, benefits, and the potential for advancement. While the median salary for recent DTCC graduates with a degree in Business or Computer Science is between \$25,000 and \$35,000, the most recent salary estimate from GlassDoor for data analysts in the Delaware region is over \$55,000. Also, the Bureau of Labor Statistics highlights some of the most relevant and in demand career options as (salaries provided are 10 – 50% national salary ranges):

- Market research analyst: \$33 – 60K/year
- Credit analyst: \$36 – 60K/year
- Management analyst: \$43 – 78K/year
- Budget analyst: \$45 – 69K/year

Delaware Tech excels in ensuring a stable, diverse workforce for Delaware.

While there is clearly a need for qualified graduates capable of filling various needs in the industry, there is a shortage of academic institutions locally available to train these students. According to the Delaware Economic Development Office, more than half of all U.S. public companies are incorporated in the Delaware, including 60% of all Fortune 500 companies. This includes prosperous industries ranging from aviation and agriculture to financial services and chemical manufacturing. So, as one of the primary missions of DTCC is create beneficial partnerships with local industry to produce a more qualified workforce, there should be plenty of opportunities to contribute to the solution of this problem within a new data science degree program.

Appendix F

DTCC DATA ANALYTICS CURRICULUM

Descriptions of Courses Required for Data Analytics A.A.S. (DAS) Degree

DATA ANALYTICS (23 credits) *Proposed New Courses

DAS 110 – Introduction to Analytics

This hands-on introductory course provides students with knowledge of business analytics in the skills necessary to utilize data and analytics to analyze business problems. Topics include an overview of the analytical process and the role of the analyst, applied descriptive statistics, and exploratory data analysis. In addition to understanding the current environment of business analytics, students will gain hands-on knowledge of the features of Excel that support the use of data for decision making. This includes functions to reference and manipulate data, pivot tables to effectively organize data, and graphs and charts to communicate results visually.

DAS 121 – Data Visualization

This course introduces key concepts in data visualization and reporting. Topics include concepts and methods used in graphical representation of data, exploration and reporting of data, and basic linear regression methods. Upon completion, students should be able to effectively use graphical tools to communicate insights about data while utilizing tools and techniques required to present complex data in visually meaningful representations.

DAS 220 Applied Data Programming

This course covers applications of statistical software for data management and reporting. Topics include data management, data preprocessing, and modeling including linear and logistic regression analysis using programming tools. Upon completion, students should be able to process data and generate reports that support data supported decision-making.

DAS 240 Introduction to Predictive Modeling

This course introduces foundations of predictive analytics and covers the key concepts necessary to extract stored data elements, understand what they mean from a business point of view, and transform their formats and derive new relationships among them to produce a dataset suitable for analytical modeling. Topics include basic predictive modeling methods for both classification and regression tasks. Upon completion, students should be able to produce a fully processed data set compatible for building and validating powerful predictive models that can be deployed to increase profitability.

DAS 241 Applied Predictive Modeling

This course covers applications of predictive models. Topics include the use of classification and regression models in real-world scenarios, utilizing advanced exploratory data analysis, nonparametric inference and simulation for larger datasets, logistic regression modeling, statistical programming, and basics of machine learning. Upon completion, students should be able to utilize their knowledge and skills in predictive analytics to independently guide decision makers.

DAS 250 Data Structures for Analytics

This course is designed to enhance student proficiency in data management skills for analytics applications. Topics include techniques and methods for identification, extraction, and preparation of data for processing with analytical software. Upon completion, students should be able to demonstrate the skills necessary to effectively organize and combine different data sources for analytic applications.

DAS 260 Analytical Tools and Methods

This course covers advanced statistical and analytic tools for use in decision-making. Topics include an overview of data mining, analysis of semi-structured and unstructured data, and text analytics. Upon completion, students should be able to analyze complex data with modern analytical tools and methods.

DAS 290 – Data Analytics Capstone

This course serves as a final project for students who are seeking A.A.S. degree in Data Analytics. Students will need to combine knowledge gained in statistics, advanced programming language concepts, and data extraction techniques to research a topic, perform data analysis and create a professional report. Students will gain comprehensive experience and demonstrate their competence in applying the knowledge and skills learned in this program to real or hypothetical case studies. While students are encouraged to identify and work on projects in actual business or non-profit organizations, they may also work on equivalent hypothetical cases mutually agreed upon by the students and the instructor. The coursework culminates in a portfolio that will be used to evaluate student competencies in the program.

BUSINESS CORE (9 credits)**BUS 101 – Introduction to Business**

This course surveys business functions, including forms of business ownership, business environments, ethics, management, production, marketing, financial markets, and accounting.

MGT 112 – Principles of Management

This course is an introduction to the management field presenting a systemized body of knowledge through the functions of planning, organizing, staffing, motivating, controlling, and using strategies to deal with internal and external environment forces.

ECO 122 – Microeconomics

This course covers the basic principles of supply and demand as they impact the American economy. Special emphasis is placed on those national policy decisions that influence individual consumers and American businesses.

ENGLISH (9 credits)

ENG 101 – Critical Thinking and Writing

This college-level course is designed to teach the concepts of critical thinking and reading skills in the context of written response and essay writing. This course introduces and reinforces the skills necessary to complete academic essays and to respond to diverse texts in meaningful ways.

ENG 102 – Composition and Research

This college-level course is designed to enhance writing, research, and speaking skills and to provide academic writing and reasoning skills to foster lifelong learning.

ENG 122 – Technical Writing and Communication

This advanced college-level course is designed to enhance skills in the creation of professional communications and reports through interpretation and analysis of primary and secondary sources.

COMPUTER AND INFORMATION SCIENCES (7 credits)

CIS 120 – Introduction to Programming

This course provides students with an introduction to the design and implementation of basic computer programming. Topics include logic development, control structures, variables, input/output, and debugging techniques of modern programming.

CIS 138 – Database Design and Programming

This course introduces statistical software for analytics, including the use of structured query language (SQL). Students acquire working knowledge of the databases necessary to apply and manage the key features such as creating, updating, and reporting. Topics include data management, data visualization, and exploratory data analysis. Upon completion, students should be able to use statistical programming tools to conduct descriptive analytics.

MATHEMATICS (8 credits)

MAT 190 – Mathematics of Analytics *New Course

This survey course provides students with mathematical concepts and methods used in data analysis. Topics include linear and non-linear algebraic functions, exponential and logarithmic functions, systems of linear equations and inequalities, vectors and matrices, linear programming, elementary probability, and the mathematics of finance.

MAT 155 – Statistics I

This course covers the basic concepts of data organization, measures of central tendency, variability probability and probability distributions, sampling and sampling distributions, estimation dealing with population means and proportions of large and small samples, and hypothesis testing. Topics include techniques of applied problem solving.

DTCC Data Analytics Program Advisement Sheet



CAMPUS LOCATION: Wilmington, Stanton
Curriculum: A.A.S. Data Analytics
Effective:

COURSE SEQUENCE SHEET
Curriculum Code Designation: XXXXXXXX

<input type="checkbox"/> No	<input type="checkbox"/> ENG 006	<input type="checkbox"/> MAT 005
Developmental	<input type="checkbox"/> ENG 007	<input type="checkbox"/> NCS 005
Education	<input type="checkbox"/> ENG 090	<input type="checkbox"/> MAT 010
Requirements	<input type="checkbox"/> ENG 091	<input type="checkbox"/> NCS 010
		<input type="checkbox"/> MAT 020

Name: _____

ID#: _____

Matriculation Date: _____

SSC 100 is a pre-requisite for all developmental and 100-level courses.

COURSE NUMBER AND TITLE	Credits	Lecture	Lab	SEMESTER		Grade	PREREQUISITES
				Offered	Completed		
FIRST SEMESTER (FALL)							
BUS 101 Intro to Business	3	3	0				ENG 090 or ENG 091 or EAP 093
CIS 120 Intro to Programming	4	3	2				ENG 090 or ENG 091, MAT 020
ENG 101 Critical Thinking & Writing	3	3	0				ENG 090 or ENG 091 or EAP 093
DAS 110 Intro to Analytics	3	3	1				
MGT 112 Principles of Management	3	3	1				
TOTAL	16						
SECOND SEMESTER (SPRING)							
CIS 138 Database and Design	3	3	1				BUS 101 or ENT 101, ENG 102 or conc.
ENG 102 Composition & Research	3	3	0				ENG 101
MAT 155 Statistics I	3	3	0				MAT020
DAS 121 Data Visualization	3	3	1				
DAS 220 Applied Data Programming	3	3	1				
TOTAL	15						
THIRD SEMESTER (FALL)							
MAT 190 Mathematics of Analysis	3	3	0				BUS 101, ENG 102
ENG 122 Technical Writing and Comm.	3	3	0				
DAS 240 Intro to Predictive Modeling	3	3	1				
DAS 250 Data Structures for Analytics	3	3	1				
Elective I*	3						
TOTAL	15						
FOURTH SEMESTER (SPRING)							
ECO 122 Microeconomics	3	3	0				MAT 010, ENG 090 or ENG 091
DAS 260 Analytical Tools and Methods	3	3	1				
DAS 241 Applied Predictive Modeling	3	3	1				
DAS 290 Data Analytics Capstone	3	1	3				
Elective II**	3						
TOTAL	15						
GRAND TOTAL	61						

***Choose Elective I:**

LOM 100 Logistics
 BUS 203 Business Law
 ACC 101 Accounting I
 MAT 156 Statistics II

****Choose Elective II:**

MKT 212 Principles of Marketing
 SOC 215 Business Ethics
 LOM 241 Supply Chain Management
 LOM 255 Statistical Quality Management

DTCC DAS Certificate Option



Certificate Program in Data Analytics

CAMPUS LOCATION: Wilmington, Stanton

Curriculum: Certificate in Data Analytics

Curriculum Code Designation: XXXXXXX
Effective:

COURSE NUMBER AND TITLE	Credits	Lecture	Lab
DAS 220 Applied Data Programming	3	3	1
DAS 240 Intro to Predictive Modeling	3	3	1
DAS 241 Applied Predictive Modeling	3	3	1
DAS 260 Analytical Tools and Methods	3	3	1
DAS 290 Data Analytics Capstone	2	2	1
TOTAL	14		

Appendix G

DTCC PROPOSAL FOR DATA ANALYTICS PROGRAM



**Proposal for
Data Analytics
Associate Degree (A.A.S.) Program**

Proposal Background

In October 2015, the Deans of Instruction and Academic Affairs were presented with a request to conduct an exploratory study to determine if it was feasible to offer an associate data analytics degree program at Delaware Technical & Community College. The request was approved and a program development workgroup was appointed and consisted of the following representatives:

- Department Chairs from Business, Computer Science, Nursing, Mathematics, and Engineering
- Director of Institutional Research
- Faculty from Mathematics, Computer Science, Nursing, and Business
- Director of Established Program to Stimulate Competitive Research (EPSCoR) Project
- Industry representatives in the fields of analytics

Throughout a series of program design meetings, discussions took place regarding the various competencies and program outcomes that could be possible for a program of this nature. Additionally, an industry needs assessment was conducted to determine the feasibility and marketability of this program. What follows in this proposal is a summary of extensive research that was completed to support the development and implementation of a new A.A.S. degree in Data Analytics at Delaware Technical & Community College.

Need for the Program

Data analytics includes the study of data in business and industry using computer technology, statistical analysis, and predictive modeling to gain insight for improving future performance. Nearly every enterprise including consumer products, media, insurance, financial services, education and health care has a growing need for workers with analytics skills. Graduates should qualify for employment in the fields of

finance, banking, logistics, marketing, healthcare, manufacturing, information technology, and government organizations.

Recent studies (Aasheim, Williams, Rutner, & Gardiner, 2015; Hardin et al., 2015) have shown that very few colleges and universities across the U.S. offer data science and analytics programs at varied academic levels. Additionally, research indicates that by 2018, the U.S. alone will face a shortage of 140,000 to 190,000 professionals with the necessary analytical skills to make effective decisions (Zhao & Zhao, 2016). Currently, Delaware Technical Community College does not offer any programs in data science or analytics.

In a joint study conducted by the American Statistical Association and the Society for Human Resource Management (SHRM, 2016), researchers aimed to address the supply and demand of workforce development in the data analytics field while identifying key skills necessary to meet industry needs. Their findings show that 82% of organizations currently have positions in the data science field, with 59% indicating that they expect the number of required positions to grow over the next five years. The most common fields for these positions are accounting and finance (71%), human resources (54%) and business administration (50%), with 60% of organizations across all sectors requiring senior management to have data analysis skills. As this is certainly a positive indicator for the field as a whole, researchers also found that within the last year, more than 78% of organizations reported difficulty in effectively recruiting for these critical data analytics positions.

A 2011 report by the McKinsey Global Institute noted that the data industry is growing at a rate of 40% each year and predicts that by 2018, the United States will face a talent gap of 50-60% relative to supply, as well as a deficit of 1.5 million

managers and analysts who can effectively analyze data for purposes of decision making (Cárdenas-Navia & Fitzgerald, 2015). Davenport and Patil (2012) similarly suggest that there is a scarcity of people with the unique skill set (math, statistics, probability, programming, and business skills) to deal with large-scale data. As such, institutions of higher education (IHEs), including community colleges, must be at the forefront of preparing students to meet these industry needs. In 2014, The American Association of Community Colleges (AACC) published their implementation guide to improve and empower the nation's community colleges. In *Empowering Community Colleges to Build the Nation's Future*, they recommend that to close the skills gap, community colleges will need to build capacity for identifying unfilled labor market needs and ensure that career education and training programs are targeted to address those high-need areas. One way to do this is building local, regional, and national partnerships (involving community colleges, employers, and government agencies) to accomplish a collaborative agenda that includes targeting skills gaps, promoting the associate degree as a desired employment credential, and establishing alternative models for completing skills-based credentials (AACC, 2014). The primary goal of this study is to research the most effective and efficient ways to move Delaware Technical Community College in this direction within the context of a new data analytics degree program.

While there is extensive research to highlight the need for qualified data scientists at the national level, there is also research to show a similar need in the local regions served by Delaware Technical Community College. In the most recent state of Delaware labor market demand report released by the Education Advisory Board, it was found that data scientists and business analysts are experiencing high demand

with emerging employers, and data analytics skills make up four of the top five “fastest growing skills” that employers are looking for. Similar trends were also found for the surrounding states of Pennsylvania, Maryland, and New Jersey (Education Advisory Board, 2015). Additionally, a similar 2015 study conducted by Burning Glass Labor found over 3,000 online job postings in 13 counties in and around Delaware that were advertising for data science and business analytics positions (CIRWA, 2015). But considering the speed at which the field is growing, it is likely that these numbers already underestimate the current need.

The continuous improvement of technologies and techniques in data science are transforming organizations into data-intensive enterprises, but despite the resulting demand for experienced and knowledgeable graduates in the field, undergraduate education has been slow to respond. Currently, most data science instruction found at four-year higher education institutions is still housed within schools of engineering or computer science, largely limiting these crucial skills and opportunities to STEM graduates (Cárdenas-Navia & Fitzgerald, 2015). It is clear that colleges and universities should begin developing degree programs that will produce qualified graduates. This should include students who can apply a variety of tools and techniques to manage and identify patterns in unstructured data while applying analytics to gain business insights that lead to improved decision making. Although academic institutions are working to develop relevant programs, the supply of appropriately skilled graduates still lags behind the demand (Dumbill, Liddy, Stanton, Mueller, & Farnham, 2013). Given that data science and analytics is a multi-disciplinary field, workers will require a variety of talents, knowledge and skills.

Because of this, a variety of degree programs will be needed at all levels of education, not just at the graduate levels (Aasheim et al., 2015).

The current state of supply and demand in the data science field presents an excellent opportunity for Delaware Technical Community College. While there is clearly a need for qualified graduates capable of filling various needs in the industry, there is a shortage of academic institutions locally available to train these students so that they can garner positions in a rapidly-growing local industry. According to the Delaware Economic Development Office, more than half of all U.S. public companies are incorporated in the Delaware, including 60% of all Fortune 500 companies. This includes prosperous industries ranging from aviation and agriculture to financial services and chemical manufacturing (Delaware Economic Development Office, 2017). So, as one of the primary missions of DTCC is create beneficial partnerships with local industry to produce a more qualified workforce, there should be plenty of opportunities to contribute to the solution of this problem within a new data analytics degree program.

Data Analytics A.A.S. Program Mission

The Data Analytics (DAS) program provides students with the knowledge and the skills necessary for employment and growth in analytical professions. Students complete cross-disciplinary course work and projects in analytics, business intelligence, data mining, visualization, data warehousing, predictive modeling, project and operations management, statistical analysis, and relevant software packages. Students will learn to discover and interpret patterns and relationships in data, make data-driven decisions, and practice critical thinking skills to be competitive across a spectrum of industries.

Program Description

The Data Analytics curriculum is designed to provide students with the knowledge and the skills necessary for employment and growth in analytical professions. Data analysts process and analyze essential information about organizational operations and also assimilate data for forecasting purposes. Students will complete course work in analytics, business intelligence, data mining, data warehousing, predictive modeling, project and operations management, statistical analysis, and software packages. Related skills include business communication, critical thinking and decision making. Graduates will qualify for employment as data technicians, data scientists, business and data analytics engineers, and business analysts in the fields of finance, banking, logistics, marketing, healthcare, manufacturing, information technology, and government organizations.

This program will be interdisciplinary in nature and will include content from computer science, mathematics, and business. The curriculum will be hands-on and application based with authentic assessments informed by partnerships with local and national industry. In order to ensure industry consistency and improve opportunities for articulation and transfer agreements, nationally recognized research and standards such as the Guidelines for Assessment and Instruction in Statistics Education (GAISE), and the American Association of Community Colleges (AACC) will be consulted. These national standards for statistics and data science have been developed because traditional statistics curricula have not kept up with pressing demands for graduates who can make sense of data, and will therefore be used to inform program curriculum design for the new A.A.S. in data analytics at DTCC.

In addition to the A.A.S. degree, students will also have the opportunity to earn a credentialed certificate along the way to increase student motivation and the value of the program to employers. This certificate consists of the following DAS courses:

- DAS 220 Applied Data Programming
- DAS 240 Introduction to Predictive Modeling
- DAS 241 Applied Predictive Modeling
- DAS 260 Analytical Tools and Methods
- DAS 290 Data Analytics Capstone

Upon completion of these select courses, students will earn a certificate in Data Analytics. This will be a valuable addition for students who may already have bachelors or graduate degrees in other fields. It will be the goal of the DAS program to further develop additional certificates as need and resources dictate throughout the implementation of the program.

Unlike various competitive DTCC programs in the health sciences such as nursing and medical sonography, there are no qualifying pools for DAS applicants who desire to pursue a degree or certificate in data analytics. Therefore, the program is open to any student who meets the basic Delaware Technical Community College admission and developmental education requirements, and is tailored to a wide spectrum of students who come with varying education and skill levels. The Associate in Applied Science (AAS) BAS degree is primarily designed for individuals who do not have a degree (e.g., high school graduates, underemployed workers, etc.); whereas the certificate is available for individuals who possibly hold advanced degrees and may already be employed, but need to expand their skill sets and strengthen their resume.

Program Outcomes

1. Apply statistical and analytical theory to problems
2. Use data mining and warehousing to identify trends
3. Utilize predictive modeling to make recommendations
4. Apply project and operations management
5. Use and analyze trends in analytical tools and techniques

Core Curriculum Competencies:

1. Communicate clearly and effectively both orally and in writing.
2. Demonstrate effective problem solving and reasoning skills.
3. Work effectively in groups of people from diverse backgrounds.
4. Demonstrate ethical and professional understanding and conduct.
5. Apply appropriate information literacy skills to locate, evaluate, and use information effectively.
6. Use computers or related technology for practical and/or professional applications.
7. Apply scientific inquiry and mathematical reasoning to practical problems.

Admission Criteria

It is proposed that the DAS program have minimum pre-requisites to attract students from a wide range of educational backgrounds and experiences. These would be the same for other college level programs by requiring that students successfully test out of or complete the developmental requirements of English and Mathematics. This is in line with the mission of DTCC to offer comprehensive educational opportunities that contribute to the economic vitality of the state of Delaware by

preparing students with knowledge and skills needed for employment in a competitive workforce across a range of occupational levels.

Program Organizational Structure

While the DAS program will initially be offered out of the Stanton/George campus, it will eventually be college wide with a new Instructional Director serving as lead and having direct supervision of the DAS AAS program. There will be a Program Coordinator at three campus locations (Wilmington, Dover, and Georgetown), who will report to the Instructional Director. The Program Coordinators will be a point of contact for the program, serve as the primary instructors for the program, advise current and prospective students, coordinate clinical agency agreements, and maintain curriculum consistency.

Conclusion

The community college mission has been to provide open access and prepare graduates for entry-level jobs. And while data analytics has traditionally been offered only at bachelors or graduate levels at academic institutions across the country, offering a new analytics associate program at a community college is an extension of the mission to serve a diverse population of students through open access, and meet the needs of the local employers and strengthen the economy. This program could put Delaware Technical Community College at the forefront of this new movement for educating the region's most in-demand workforce of data analysts.

References

- AACC. (2012) . *Reclaiming the American dream, community colleges and the nation's future: a report from the 21st-Century Commission on the Future of Community Colleges* Washington D.C.. American Association of Community Colleges
- Aasheim, C., Williams, S., Rutner, P., & Gardiner, A. (2015). Big data analytics and data science undergraduate degree programs. *Decision Sciences Institute*.
- Cárdenas-Navia, I., & Fitzgerald, B. K. (2015). The Broad Application of Data Science and Analytics: Essential Tools for the Liberal Arts Graduate. *Change: The Magazine of Higher Learning*, 47(4), 25–32.
- CIRWA. (2015). *Computer and Information Technology Occupational Analysis*. Delaware Technical Community College. Wilmington, DE.
- Davenport, T. H., & Patil, D. J. (2012). Data scientist: the sexiest job of the 21st century. *Harvard Business Review*, 90(10), 70–77.
- Dumbill, E., Liddy, E. D., Stanton, J., Mueller, K., & Farnham, S. (2013). Educating the Next Generation of Data Scientists. *Big Data*, 1(1), 21–27.
- Education Advisory Board. (2015). *State Employer Demand Dashboards*.
- Hardin, J., Hoerl, R., Horton, N. J., Nolan, D., Baumer, B., Hall-Holt, O., ... Ward, M. D. (2015). Data Science in Statistics Curricula: Preparing Students to “Think with Data.” *The American Statistician*, 69(4), 343–353.
- SHRM. (2016). *Jobs of the Future : Data Analysis Skills Table of Contents*. Society for Human Resource Management.

Zhao, J., & Zhao, S. Y. (2016). Business analytics programs offered by AACSB-accredited U.S. colleges of business: A web mining study. *Journal of Education for Business*, 91(6), 327–337.

Appendix H

PROGRAM REVIEW ASSESSMENT PLAN FOR DATA ANALYTICS



Program Review Assessment for
Data Analytics A.A.S.

2018 – 2023

Program Mission

The Data Analytics (DAS) program provides students with the knowledge and the skills necessary for employment and growth in analytical professions. Students complete cross-disciplinary course work and projects in analytics, business intelligence, data mining, visualization, data warehousing, predictive modeling, project and operations management, statistical analysis, and relevant software packages. Students will learn to recognize and interpret patterns and relationships in data, make data-driven decisions, and practice critical thinking skills to be competitive across a spectrum of industries.

Program Credentials

AAS Curriculum Description

The Data Analytics curriculum is designed to prepare students for a variety of opportunities in data science and analytics including workforce preparation, industry advancement, and transfer to a four-year institution. Data analysts process and analyze essential information about organizational operations and also assimilate data for forecasting purposes. Students will complete course work in analytics, business intelligence, data mining, data warehousing, predictive modeling, project and operations management, statistical analysis, and software packages. Related skills include business communication, critical thinking and decision making. Given successful completion of program requirements, graduates should qualify for employment as data technicians, data scientists, business and data analytics engineers, and business analysts in the fields of finance, banking, logistics, marketing, healthcare, manufacturing, information technology, and government organizations.

In addition to the A.A.S. degree, students will also have the opportunity to earn a credentialed certificate to increase student motivation and the value of the program to employers. Upon completion of these select courses, students will earn a highly marketable certificate in Data Analytics. This will be a valuable addition for students who may already have bachelors or graduate degrees in other fields. It will be the goal of the DAS program to further develop additional certificates as needs and resources dictate throughout the implementation of the program.

Various competitive Delaware Technical Community College (DTCC) programs in the health sciences such as nursing and medical sonography have qualifying pools of applicants. DAS does not have a similar pool of individuals who want to pursue a degree or certificate in data analytics. Therefore, the program is open to any student who meets the basic Delaware Technical Community College admission and developmental education requirements, and is tailored to a wide spectrum of students who enter with varying education and skill levels. The Associate in Applied Science (A.A.S.) DAS degree is primarily designed for individuals who do not have a degree (e.g., high school graduates, underemployed workers, etc.); whereas the certificate is available for individuals who may hold advanced degrees or already be employed, but need to expand their skill sets and strengthen their resumes.

Context for Assessment

Delaware Technical Community College is a statewide multi-campus community college with the mission of “providing affordable, open admission, post-secondary education that is relevant and responsive to labor market and community needs. The College offers comprehensive educational opportunities that contribute to

the economic vitality of the State, including career, general, developmental, and transfer education; workforce development; and lifelong learning. The College respects its students as individuals and as members of diverse groups and is committed to fostering student success in higher education as a means to economic and personal advancement” (DTCC, 2016b). The College aims to achieve this mission through the following College Goals:

1. Academic programs will prepare students with knowledge and skills needed for employment in their career field of study and/or for transfer to a senior institution.
2. Developmental education will prepare students in mathematics, reading, and writing to be successful in entry-level College courses and workforce development programs.
3. Academic and workforce development programs will prepare and support a competitive workforce across a range of occupational levels.
4. Personal enrichment programs and events will support lifelong learning in the community.
5. The College will provide an inclusive environment that promotes respect for diverse cultures, abilities, and points of view.
6. Programs, activities, and services will cultivate student learning and success.
7. Public and private resources and partnerships will be identified, obtained, and utilized to advance the College Mission and Goals.

In order to align these goals with the demands of industry and external stakeholders, Delaware Technical Community College has developed a series of Strategic Directions. These respond to trends in the external environment that will impact accomplishment of the College mission and vision. The Strategic Directions

position the College to successfully address opportunities and obstacles presented by external trends. The Strategic Directions serve as the foundation for developing strategic goals in the College and Campus Plans (DTCC, 2016c).

The 2017 - 2021 Strategic Directions are:

1. Advance the delivery of innovative instructional offerings, such as pathways and stackable credentials, to meet competitive workforce needs and increase educational and career opportunities for students.
2. Diversify and strengthen revenue streams to address aging infrastructure, alleviate impact of rising costs for students, and achieve College priorities.
3. Optimize strategic partnerships to respond to employer needs, augment operational and fiscal resources, and promote mutual interests.
4. Increase data-driven decision-making at all levels and promote transparency by disseminating information and developing the infrastructure needed to support use of data.
5. Transform learning spaces to accommodate collaborative learning, incorporate advanced technology and new media, and engage the College's diverse student population.
6. Foster a culture of inclusion that values, respects, recruits, and retains a diverse college community.
7. Leverage the College's framework of accountability by anticipating and responding to regulatory changes, expanding use of technology, and enhancing communication of outcomes.

In addition, the College is accountable to the Middle States Commission of Higher Education (MSCHE) for accreditation. Specifically, Standards III - VI of the Standards for Accreditation and Requirements of Affiliation are used to inform the College's Program Review Assessment Plan. (MSCHE, 2014)

Standard III: Design and Delivery of the Student Experience. An institution provides students with learning experiences that are characterized by rigor and coherence at all program, certificate, and degree levels, regardless of instructional modality. All learning experiences, regardless of modality, program pace/schedule, level, and setting are consistent with higher education expectations.

Standard IV: Support of the Student Experience. Across all educational experiences, settings, levels, and instructional modalities, the institution recruits and admits students whose interests, abilities, experiences, and goals are congruent with its mission and educational offerings. The institution commits to student retention, persistence, completion, and success through a coherent and effective support system sustained by qualified professionals, which enhances the quality of the learning environment, contributes to the educational experience, and fosters student success.

Standard V: Educational Effectiveness Assessment. Assessment of student learning and achievement demonstrates that the institution's students have accomplished educational goals consistent with their program of study, degree level, the institution's mission, and appropriate expectations for institutions of higher education.

Standard VI: Planning, Resources, and Institutional Improvement. The institution's planning processes, resources, and structures are aligned with each other and are sufficient to fulfill its mission and goals, to continuously assess and improve its programs and services, and to respond effectively to opportunities and challenges.

Assessment Principles and Guidelines

Assessment reporting must align with college expectations for both program and student learning outcomes. The following framework outlines the principles and guidelines for evaluating performance, collecting evidence and artifacts to support this evaluation, and methods of analyses that support continued improvement.

Program Review Assessment

Program Review is conducted to ensure academic programs remain relevant to the College Mission, demonstrate alignment with Middle States' standards, and operate effectively and efficiently with adequate resources necessary for success. The spirit of Program Review is analytical and collaborative, while the purpose of Program Review is improvement. Department Chairpersons and faculty collect and analyze program data to determine the extent to which academic programs exhibit the standards described below in the Program Review Plan. Assessment for program and student learning outcomes will be conducted in the context of continued improvement. The program should maintain evidence that the results of these outcomes are part of self-evaluation, planning, and improvement of the program. Examples of this evidence includes development of leadership teams to ensure effective decision making. Meeting minutes and reports, in addition to the annual assessment report, may serve as evidence of engagement and use of data to support student achievement and overall improvement of the program. Strategies should include improving access to resources and best practices, as well as strengthening innovation, growth, instructional, and assessment practices.

Student Learning Outcomes Assessment

Student Learning Outcomes Assessment (SLOA) is a process for the assessment of student learning through Program Graduate Competencies for the purpose of improvement. Delaware Technical Community College has a firm foundation for assessment of student learning outcomes. The College Mission Statement sets the direction for student learning in these areas: career education, general education, developmental education, transfer education, lifelong learning and workforce education and training. Program Graduate Competencies provide structure for career and transfer education. Student learning outcomes are assessed through embedded course assessments. Measurements include tests, exams, and the use of rubrics for projects and writing assignments (DTCC, 2012a). These tools represent the authentic assessment that takes place within the classroom and provide the most accurate measure of student performance.

Program graduate outcomes will be reviewed using the following SLOA guidelines:

1. Each associate degree program has a mission statement and student learning goals that are linked to the College Mission Statement.
2. Each associate degree program has Program Graduate Competencies designed to demonstrate student readiness for employment in the relevant career field and/or readiness for transfer to a senior institution.
3. Each associate degree program addresses the Core Curriculum Competencies to demonstrate student acquisition of the College's general education learning outcomes.
4. Each associate degree program ensures that the curriculum and courses support student achievement of Program Graduate and Core Curriculum Competencies by relating Core Course Performance Objectives to those Competencies.

5. Each course is structured with well-defined measurable performance objectives under the Core Course Performance Objectives.
6. Assessment strategies are diverse and appropriate for the particular program and correspond to the Program Graduate and Core Curriculum Competencies at the program level and the performance objectives at the course level. Faculty select intended outcomes and means of assessment for the Program Graduate and Core Curriculum Competencies. Multi-campus programs jointly assess at least one Program Graduate Competency and intended outcome, in addition to conducting assessment at the campus. Core Curriculum Competencies are assessed in accordance with the process specified in the Integrated General Education Instruction and Assessment Plan.
7. Assessment results are used to improve student learning, in which case, changes may be made to improve Core Curriculum or Program Graduate Competencies, course content, course delivery methods and program and course assessment strategies. Assessment outcomes are shared across campuses in college wide programs to improve student learning outcomes.
8. At annual department chairperson workshops, institutional and program level assessment outcomes will be reviewed. Recommendations will be made to improve student learning outcomes and the SLOA process. These recommendations will be used in campus and College planning if improvements cannot be made immediately and require planning future actions.
9. At Corporate and Community Programs staff meetings, Occupational Skills certificate program assessment outcomes will be reviewed. Recommendations will be made to improve student learning outcomes and the SLOA process. These recommendations will be used in campus and College planning if improvements cannot be made immediately and require planning future actions.

Roles and Responsibilities for Program Review Assessment

College wide roles for assessment consist of shared responsibilities to ensure alignment, consistency, and ongoing improvement. Among these shared responsibilities are the specific duties as established in the Institutional Effectiveness Structure (DTCC, 2012b).

Vice President for Institutional Effectiveness: Provides administrative oversight for college wide assessment to include mission goal outcomes, student learning outcomes, and educational support outcomes, and ensure connections to the College planning and budgeting processes where appropriate.

Planning and Institutional Effectiveness Director: Provides leadership for planning, assessment, and accreditation for the College. Provides leadership for development, implementation and improvement of the College Institutional Effectiveness Structure. Chairs the College Assessment Committee. Provides guidance and consultation to the Vice Presidents and Mission Goal Leadership Groups for institutional-level Mission Goal Outcomes Assessment. Provides consultation and guidance to the Vice Presidents, Campus Assessment Coordinators, and Deans/Directors for SLOA. Provides leadership for strategic planning, long range College planning, and annual campus planning. Chairs the College Planning Council.

Director of Institutional Research: Provides consultation to Campus Assessment Coordinators on data collection, management, analysis and reporting related to student learning and educational support services outcomes. Works with Campus Assessment Coordinators to design and create database capabilities that address the needs of campus and college wide assessment plans. Provides information and advice on using the College's databases. Integrates campus data requests and organizes and conducts College data collection such as surveys. Produces data reports

for SLOA and Mission. Produces analytical reports to support College projects including Mission Goal Outcomes Assessment.

Campus Assessment Coordinators: Under the leadership of the Planning and Institutional Effectiveness Director, provides assessment design and analysis support (guidance, training and consultation) for SLOA at the campus; chairs campus SLOA Committees; serves on Campus Planning Council and on College Assessment Committee and ensures campus assessment progress. Collaborates with other Campus Assessment Coordinators and the Director of Institutional Research to assist faculty and staff with the design, analysis and report of college wide SLOA plans/results.

Faculty: Faculty members are responsible for collaborative review and revision of course-level outcomes under the leadership of the respective department head/program coordinator. They will ensure curriculum aligns with programmatic and course-level outcomes. They will participate in the assessment process through establishment of assessment tools, collection of assessment artifacts, and reporting of student performance measures. Faculty will also participate in reflection of assessment practices and recommend improvement strategies and interventions. They will be primarily responsible for implementation of improvement strategies and interventions.

Program Review Assessment Timeline

The college wide Deans of Instruction and the Vice President for Academic Affairs establish a five-year cycle of programs to conduct Program Review. The Deans and Vice President may change the five-year cycle to move programs for review earlier based on annual data results including enrollment, retention, graduation and job placement trends. All programs, regardless of trends, conduct Program Review at least once every five years. Data collection and analysis occurs throughout

the assessment year. Action plans are established yearly at the end of the assessment cycle. Specific components of the program review are shown in the Program Review and Assessment Matrix (Appendix A).

Program Review Plan

Program review provides an opportunity to analyze an academic offering's operational effectiveness in comparison to the standards below and to plan improvements (DTCC, 2017). *Data denoted with an asterisk will be provided by the Director of Institutional Research.

Assessing Operational Goals

Operational Standard 1: The program's student learning goals are current, appropriate for associate degree or bachelor degree graduate level, and supported by curriculum that is relevant and complies with College curricular requirements. The program's operational goals support the College Mission and Vision.

1. Program Mission
2. Goals and Objectives
 - a. Student Learning Goals (i.e., Program Graduate Competencies)
 - b. Program operational goals/objectives and achievements for the last three years
 - c. Program compliance with College Curriculum Guidelines' curricular requirements including: credits required in Core, Program/Major Support, and Program/Major course areas; Comparison of Program Graduate Competencies of academic programs and their related program options

Operational Standard 2: *The program is relevant to the labor market in the program area.*

1. Graduate Employment in the Career Field Rates* in field of study.
2. Employment projections for Delaware in occupations related to the program
3. Transfer Rates*
 - a. Transfer intentions per graduate survey responses including intended institutions and majors, actual transfer rate per National Student Clearinghouse the fall after graduation and retention at the senior institution in the next semester (spring following graduation), and student success after transfer*
 - b. Licensure/National Exam Pass Rates, if applicable
 - c. Advisory Committee and Department Review of Program Graduate Competencies and curriculum regarding relevance to labor market needs
 - d. Results of Employer/Business/Industry Survey
 - e. Analysis of program's relevance to the labor market and its effectiveness in enabling students to secure employment in the field. Include a summary of what the department/faculty have done to support or increase job placement in the career field over the last five years and the effectiveness of these actions.
 - f. If the program intends to enable student transfer, analysis of program effectiveness in preparing students for success after transfer

Operational Standard 3: *The program has a Student Learning Outcomes Assessment Plan and uses the results for program improvement.*

Attach Student Learning Outcomes Assessment (SLOA) Records for the past five years and the current SLOA Plan. Summarize how SLOA has been used in a meaningful way to improve student learning and program effectiveness.

Operational Standard 4: *The program is accredited (as applicable).*

Provide significant results of accreditation studies. If the program is not accredited, explain whether an accrediting body exists and plans for accreditation.

Operational Standard 5: *The program monitors enrollment, retention and graduation to ensure student access and success.*

Report and analyze the new student enrollment, retention and graduation data listed below.

- a. New Student Enrollment – Three year trended report of new student enrollment including new transfer students*
- b. Retention Rates – Fall to fall data for the most recent three years*
- c. Graduation Rates - For the most recent two cohorts by program/major and by college, compared to the program's goal which will be calculated as a 50% increase over the its 2007 graduation rate by year 2020. Cohort size will also be included*
- d. Note: Data reports will include overall data and the subsets listed below.
- e. Enrollment – overall, of developmental and fully qualified students, full-time and part-time
- f. Retention – overall, for developmental and fully qualified students, full-time and part-time students
- g. Graduation – overall, of developmental and fully qualified students
- h. Degrees, Diplomas and Certificates awarded *

Operational Standard 6: *The program has adequate resources which are effectively and efficiently utilized to meet its goals. Data will be calculated by Department Chairperson unless otherwise noted.*

1. In the categories below provide data for the past year. (Additional year data may be included if the department chairperson believes it is pertinent.)

- a. Ratio of students to each advisor
 - b. The percentage and number of fall and spring classes, day and evening with fewer than 6 students in the last fiscal year *
 - c. The percentage and number of fall and spring classes, day and evening with maximum enrollment *
 - d. Total number of course sections taught by adjuncts for fall and spring, day and evening* (Include FT faculty teaching on supplemental contracts)
 - e. Total percentage of course sections taught by adjuncts for fall and spring, day and evening * (Include FT faculty teaching on supplemental contracts)
 - f. Total seats taken (for fall and spring) in all courses provided by the program*
 - g. Average number of seats taken in course sections *
2. Provide a budget trend analysis in the following categories over the past five (5) years: supplies, equipment and professional development

Operational Standard 7: *The program has articulation agreements with high schools and/or senior institutions (as applicable).*

List current senior institution Connected Degrees and high school articulation agreements. Describe any plans for articulation agreements.

Operational Standard 8: *The program creates and sustains a learning environment that supports its goals.*

1. Document how syllabi, text books and course materials are current and appropriate and are used by all faculty.
2. Document by course how instructional strategies and techniques are varied, interactive and student-centered.
3. Document how the learning management system (LMS) is used to support and enhance course delivery.

4. Document the educational background and continuing growth and development of all full-time and part-time faculty.
 - a. The Office of Instruction will provide data chart for Department Chairperson to verify and attach. Data will include the highest degree received/lane status, IDT course completion/certificate completion, New Faculty Development Program status/completion, and Leadership Development Program status/completion.
5. Document that instructors teaching in distance education formats (online and hybrid) have completed appropriate education.
6. Summarize library, instructional labs, equipment and facility resources for adequacy and relevance to the program.

Assessing Program Goals

Program graduate outcomes (competencies) are specific to the Data Analytics degree program and will be assessed using the College's SLOA process and framework (DTCC, 2012). Each year, program faculty will:

1. Review and revise Program Graduate Competencies (student learning program goals) and set intended outcomes.
2. Select at least one Program Graduate Competency and one campus intended outcome to measure, set one or more criteria for success, develop or acquire means of assessment with emphasis on direct assessment and implement appropriate measurement(s).
3. Gather and analyze assessment data.
4. Use results for program improvement.
5. Record results on the approved SLOA forms.

Program Outcome 1: Students will apply statistical and analytical theory to problems

Program Outcome 2: Students will use data mining and warehousing to identify trends

Program Outcome 3: Students will utilize predictive modeling to make recommendations

Program Outcome 4: Students will apply project and operations management strategies

Program Outcome 5: Students will use and analyze trends in analytical tools and techniques

References

- DTCC. (2012a). *Student Learning Outcomes Assessment Process*. Delaware Technical Community College. Retrieved from https://www.dtcc.edu/sites/default/files/ie_structure_sloa.pdf
- DTCC. (2012b). *Institutional Effectiveness Structure*. Delaware Technical Community College. Retrieved from https://www.dtcc.edu/sites/default/files/ie_structure_elements.pdf.
- DTCC. (2014). *Fact Book 2013/2014*. Delaware Technical Community College. Dover, Delaware.
- DTCC. (2016a). *About*. Delaware Technical Community College. Retrieved from <https://www.dtcc.edu/about>
- DTCC. (2016b). *Mission*. Delaware Technical Community College. Retrieved from <https://www.dtcc.edu/about/mission-vision-and-strategic-directions>
- DTCC. (2016c). *Strategic Directions*. Delaware Technical Community College. Dover, Delaware. Retrieved from <https://www.dtcc.edu/about/mission-vision-and-strategic-directions>
- MSCHE. (2014). *Standards for Accreditation and Requirements of Affiliation*. Middle States Commission of Higher Education. Retrieved from <http://www.msche.org/documents/RevisedStandardsFINAL.pdf>

Appendix – Program Review Assessment Matrix

AAS Data Analytics Five-Year Program Review and Assessment Plan Matrix					
Operational Standard	Assessment Schedule				
	2018- 2019	2019- 2020	2020- 2021	2021- 2022	2022- 2023
OS1: Program mission and learning goals <i>Goal Alignment #1</i>	x		x		x
OS2: Program relevance to labor market <i>Goal Alignment #3</i>			x		
OS3: Conduct SLOA review <i>Goal Alignment #1, 6</i>	x	x	x	x	x
OS4: Program accreditation <i>Goal Alignment #1, 3</i>				x	
OS5: Enrollment, retention, & graduation <i>Goal Alignment #6, 7</i>	x	x	x	x	x
OS6: Adequate and effective resources <i>Goal Alignment #1, 7</i>		x		x	
OS7: Articulation agreements <i>Goal Alignment #1, 7</i>			x		x
OS8: Learning environment <i>Goal Alignment #1, 4, 5, 6</i>	x	x	x	x	x
Program Outcomes	Assessment Schedule				
	2018- 2019	2019- 2020	2020- 2021	2021- 2022	2022- 2023
PO1: Apply statistical and analytical theory to problems <i>Course embedded assessment (DAS 121, DAS 241, DAS 290)</i>	Data	Analyze & Implement	Data	Analyze & Implement	Data
PO2: Data Mining and Data Warehousing <i>Course embedded assessment (DAS 260, DAS 290)</i>	Data	Analyze & Implement	Data	Analyze & Implement	Data
PO3: Predictive Modeling <i>Course embedded assessment (DAS 241, DAS 290)</i>		Data	Analyze & Implement	Data	Analyze & Implement
PO4: Project and Ops Mgmt <i>Course embedded assessment (DAS 241, DAS 260, DAS 290)</i>			Data	Analyze & Implement	Data
PO5: Analytics Tools and Techniques <i>Course embedded assessment (DAS 121, 241, 290)</i>				Data	Analyze & Implement

Appendix I

Author Note

The project proposal in this appendix was submitted by the American Statistical Association to the National Science Foundation in 2016. This grant was approved by the NSF on August 7, 2017 (Award #1735199). It is sponsored by the American Statistical Association and is led by the following investigators:

- Steve Pierson (Principal Investigator)
- Roxy Peck (Co-Principal Investigator)
- Robert Gould (Co-Principal Investigator)
- Mary Rudis (Co-Principal Investigator)

While I did not participate in the development or writing of this proposal, it is included here in its entirety for several reasons. First, the research presented in the project description, review of literature, and intended outcomes speak closely to my project proposal for this Education Leadership Portfolio project. This is significant in that it lends weight and support to my initial improvement goals and proposal despite the fact that this project was largely considered a long-shot or even unrealistic. It is encouraging that the American Statistical Association, the American Association of Two-Year Colleges, and the National Science Foundation all agree that this is an important topic and that the feasibility of data science in community colleges is worth being explored further. Additionally, as described earlier in this paper, I have been fortunate to have been involved in most of the initial meetings for the implementation of this project and plan on continuing to contribute to the project throughout the process to completion. So this project proposal effectively describes how I will be applying the research, skill, and experiences from my ELP work to effect change and improvement at institutions throughout the country.

NSF PROPOSAL FOR TWO-YEAR COLLEGE DATA SCIENCE SUMMIT

Project Description

The American Statistical Association proposes to convene a summit to foster the establishment and growth of data science programs at two-year colleges. This Two-Year College Data Science Summit (TYCDSS) will bring together participants in previous NSF projects that addressed data science education and representatives from two-year colleges that are developing data science programs.

Previous efforts—the Park City Math Institute 2016 Undergraduate Faculty Program (PCMI), Workshop on Exploring the Status of Education for Data Science (ESEDs, Award #1545135) and Oceans of Data Institute Pathways (ODI-P) have considered potential undergraduate data science curricula and have proposed career pathway models to guide two-year college data science programs. In addition, the National Academy of Sciences (Award #1626983) has begun convening workshops that, building on its recent roundtable on post-secondary data science education, will focus on two-year college data science. With the exception of a few overlapping participants, these projects have worked more or less independently and from different perspectives. The proposed TYCDSS will build on these projects by bringing leaders and participants from these previous projects together with faculty and administrators from two-year colleges throughout the U.S. and data professionals from a variety of industries.

Outcomes of the summit will include products that will be nationally disseminated:

- (1) A report summarizing
 - (a) the current state of data science programs at two-year colleges,

- (b) the challenges facing those working on the establishment of two-year college data science programs and
 - (c) suggestions for resources and further work to increase the number of such programs.
- (2) Guidelines for two-year college data science programs, modeled after the PCMI data science guidelines, that serve the needs of each of three student populations: those seeking employment following an associate's degree; those seeking transfer to four-year programs; those seeking certificate programs and college level courses in data science for professional development;
- (3) Documentation of resources for two-year colleges that are considering creating data science programs.

The summit will take into account the diverse nature of two-year colleges, including college mission, local job market, student body, transfer programs, and articulation agreements with four-year colleges.

Introduction/Statement of Needs and Goals

Due to the rapidly increasing role of data in commerce and science, data science has gained wide attention in a relatively short amount of time in the private sector, government, and academia. In the private sector, job advertisements for data scientists have burgeoned. The White House, the National Institutes of Health and the NSF CISE Directorate now have chief data scientist positions with dozens more such positions across the federal government. The Society for Human Resource Management reports that 82% of organizations "currently have or expect to have positions that require data analysis skills." They predict continued growth in this

demand over the next five years.¹ To meet the growing demand for data scientists and data science skills, academia has responded: dozens of data science master's programs have been created, many bachelor's programs are established,² and there are many online options.³

Recently, the NSF has funded several efforts to inform data science curriculum. The Workshop Exploring the Status of Data Science Education engaged participants in high level discussions about the future of data science education in undergraduate institutions and identified key challenges faced by those establishing data science programs.⁴ Partially building on this, the Park City Math Institute's (PCMI) Undergraduate Faculty group developed a curriculum guideline for undergraduate programs in data science.⁵ Neither of these efforts included two-year

¹ *Jobs of the Future: Data Analysis Skills*, Society for Human Resource Management Survey Findings, November 14, 2016; <https://www.shrm.org/hr-today/trends-and-forecasting/research-and-surveys/Documents/Data-Analysis-Skills.pdf>.

² E.g., Data science programs in Amstat News: magazine.amstat.org/blog/2015/07/01/new-undergraduate-data-science-programs/ and <http://magazine.amstat.org/blog/2015/08/01/new-undergraduate-data-science-programs-2/>.

³ E.g., JHU Data Science Coursera, <https://www.coursera.org/specializations/jhudatascience>

⁴ NSF Award, #1545135, Heikki Topi (Principal Investigator) and Lillian Cassel (Co-PI), https://www.nsf.gov/awardsearch/showAward?AWD_ID=1545135. Report available at http://computingportal.org/sites/default/files/Data%20Science%20Education%20Workshop%20Report%201.0_0.pdf.

⁵ *Curriculum Guidelines for Undergraduate Programs in Data Science*, Park City Math Institute (PCMI) Undergraduate Faculty Group, (Richard De Veaux, Chair),

colleges, although the PCMI guidelines identify the need for working with two-year colleges to develop courses to support transfers.

The Oceans of Data Institute has worked specifically with four two-year colleges to develop models of career pathways to support those who seek careers as "data professionals."⁶ As part of this effort, they convened a workshop to create a profile of a data practitioner and another to define data literacy in a world of big data. Their work on the career pathways is ongoing.

With funding from the National Institutes of Health, the Association for Computing Machinery, the ASA, and others, the National Academy of Sciences (NAS) is hosting quarterly roundtable meetings on data science post-secondary education.⁷ Based on feedback and comments from roundtable members from the initial roundtable meetings, NAS expects to dedicate at least one session in an early 2018 roundtable meeting to data science education at two-year colleges. The Academy is eager to maximize synergies with our proposal should it be funded. Members of their planning committee have told us the roundtable session would likely examine data science education at two-year colleges at the more programmatic level,⁸ and thus

Annu. Rev. Stat. Appl. 2017. 4:2.1–2.16; s doi: 10.1146/annurev-statistics-060116-053930. (<http://www.amstat.org/asa/files/pdfs/EDU-DataScienceGuidelines.pdf>)

⁶ NSF Award #1501927, Creating Pathways for Big Data Careers, Multiple PI's, https://www.nsf.gov/awardsearch/showAward?AWD_ID=1501927&HistoricalAward_s=false, See also this 12/12/16 article on the project on the Association for Career and Technical Education website: <http://industryconnect.acteonline.org/2016/12/what-does-the-databig-data-practitioner-need-to-know-and-be-able-to-do.html>.

⁷ http://sites.nationalacademies.org/deps/bmsa/deps_180066

⁸ Private communication.

our proposal would serve as a nice complement as we intend to provide guidance to two-year colleges at both the programmatic and course level.

In addition to the roundtable meetings, the NAS is also conducting an “Envisioning the Data Science Discipline: The Undergraduate Perspective” project sponsored by NSF.⁹ Per the scope of the original project summary¹⁰ and recent postings from NAS, a planning workshop and the first of two workshops have already occurred (December 2016 and May 2017, respectively). These workshops featured speakers representing various disciplines and various employment sectors; and one theme that resonates with two-year colleges and the aims of our proposed workshop is that of professional development for people new to the workforce and for those seeking to update their training by acquiring new skills in the area of data science. We are aware of a few community college professors attending the workshops, participating in discussions, and being engaged by others—all of which indicates a strong interest in the teaching of data science at two-year colleges. The NAS project summary also states that the next and final workshop (scheduled for December 2017) would likely focus “on pedagogy and implications for middle and high schools and community colleges” but that the workshops in general “will not consider the practicalities of creating materials, courses, or programs.” We believe that our workshop focused specifically on two-year college data-science instruction would be a valuable complement to the NAS data science efforts (and the Academies' vision for the data science discipline at the undergraduate level) given our proposal's emphasis

⁹

https://www.nsf.gov/awardsearch/showAward?AWD_ID=1626983&HistoricalAward=false

¹⁰ http://sites.nationalacademies.org/cstb/currentprojects/cstb_175246

on developing specific, program-level recommendations, documentation, and resources for two-year colleges considering data science programs.

Data science courses and programs have recently started emerging at two-year colleges. Without intending to be comprehensive we mention a few. Great Bay Community College in New Hampshire recently announced a Certificate in Practical Data Science.¹¹ Manchester Community College (NH) is still in the development phase of an Applied Data Analytics program with plans to implement statistics and data analytics courses in the spring of 2016.¹² In the closely related area of analytics, Wake Tech Community College (NC) recently started an Associate in Applied Science degree in Business Analytics.¹³ Northern Virginia Community College and Montgomery College (MD) also have faculty working on bringing data science to two-year colleges.¹⁴ We also understand that Lorain County Community College (OH) and Northern New Mexico College are pursuing data science initiatives at the two-year college level.¹⁵

Despite this progress, establishing a data science program at a two-year college remains challenging. The unique interdisciplinary nature of data science, which builds upon traditions in statistics, computer science, mathematics and engineering, may require two-year colleges to create new infrastructure to handle cross-departmental collaboration, resources for career planning, and course creation. Many two-year colleges may require assistance in developing resources to evaluate the validity or

¹¹ <http://greatbay.edu/courses/certificate-programs/data-practical-data-science>

¹² Private communication.

¹³ <http://www.waketech.edu/programs-courses/credit/business-analytics>

¹⁴ <https://twitter.com/NVCCBigDataProf>

¹⁵ Private communication

rigor of course offerings or the knowledge to evaluate instructor readiness. Indeed, identifying and training instructors is a national concern.¹⁶ Two-year colleges may also benefit from advice on how to identify and collaborate with potential local employers of data professionals.

A more fundamental challenge is to identify the types of data science jobs that students who only earn a two-year associate degree can fill. This challenge is compounded by the possibility that potential employers may not realize how a student with a terminal associate degree in data science could successfully provide to their company. Yet, potential employer input is critical to identifying the knowledge and skills students would need to work for them. A related challenge is incorporating such input from potential employers into data science courses and curricula.

There are encouraging signs that employers are becoming more sophisticated in their job postings and using terms such as "intern" and varying levels of expertise – I, II, and III and "entry level". According to one source¹⁷, among the Top 50 entry level jobs are Data Assistant, Data Mining Specialist and Statistical Assistant. Each of these has the potential to include students with an Associate degree credential along with some practical experience. Regarding the latter, there is an increasing number of volunteer and community data projects that are purportedly open to participants at very diverse levels of STEM expertise. An example of this is the "Data Refuge"¹⁸ Project, a massive collaborative and grassroots effort started by the University of

¹⁶ "The State of Data Education in 2016," Tableau, http://www.tableau.com/sites/default/files/media/the_state_of_data_education_in_2016_final.pdf.

¹⁷ <http://createacareer.org/the-50-best-entry-level-jobs/>

¹⁸ <http://www.datarefuge.org>

Pennsylvania. Experiences like this can help students to build a portfolio of projects that employers will want to see as evidence that the job applicant can actually perform relevant tasks.

A growing cadre of employers are listing "bachelor's degree" under minimum qualifications, compared with several years ago when master's degrees were almost exclusively sought; this trend represents even further evidence that varying levels of expertise are opening up for job seekers. Not only that but often employers list appropriate "field" or "work" experience as an appropriate substitute for bachelor's degree, and on the job training/mentoring is available according to several job postings found using Glass Door.¹⁹

In recognition of the potential for associate degree holders for STEM jobs, the National Science Board recently heard a proposal from one of its members for a “Blue Collar STEM” for the NSB to further explore the issue.²⁰ According to a report on the presentation, Victor McCrary said “many occupations filled by workers with high school, vocational, or two-year degrees require considerable STEM skills.”²¹

To promote the growth of two-year data science programs, we propose a two-day summit that will bring the creative forces behind these data science education projects together with community college administrators and faculty, with the intent of producing guidelines and resource materials to assist two-year colleges that wish to

¹⁹ <http://www.glassdoor.com>

²⁰ https://www.nsf.gov/nsb/meetings/2017/0221/presentations/20170221-SEP-Blue-Collar-STEM-Concepts-Opportunities.pdf?utm_medium=email&utm_source=FYI&dm_i=1ZJN,4SO2S,E29NHN,I26NN,1

²¹ <https://www.aip.org/fyi/2017/national-science-board-considering-focus-%E2%80%98blue-collar-stem%E2%80%99>

develop data science programs. This summit will also include representatives from industry, four-year colleges and universities, and relevant professional societies. Because data science is interdisciplinary, participants will include statisticians, mathematicians, computer scientists and engineers with interests and experience in data science.

Proposed Activity

The summit will include breakout sessions to discuss specific recommendations for data science curricula, and the summit will conclude with a plenary session where breakout groups report on their discussions, followed by whole-group discussion and wrap-up.

Likely presentation topics include:

- a. Reports from ODI, PCMI group, and EDES.
- b. Perspectives/experiences from two-year college instructors of data science, business analytics, statistics, and/or computer science
- c. Perspectives/experiences from existing undergraduate data science programs (minors, majors)
- d. Two-year college administrative perspectives on new curriculum, including enhancements to existing courses, and other opportunities
- e. Private sector needs and potential; job opportunities/outlook
- f. Four-year institution perspectives, including consideration of transferability
- g. Roles of statistics, mathematics, and computer science in a data science curriculum

Likely discussion session topics include:

- a. Learning outcomes for data science curricula
- b. Engagement of domain science departments (e.g., biology, health sciences), an important data science component
- c. Considerations for students planning to complete four-year degrees
- d. Considerations for students entering the workforce from two-year colleges
- e. Considerations of students in certificate programs looking to supplement job skills
- f. Technology needs and the challenges posed by the resource-challenged environment of most two-year colleges.
- g. Professional development needs and available resources for data science instructors

Summit Participants, Planners, Panelists

The steering committee will include the PIs of this proposal and the PIs of the ODI and ESEDS projects. Participants will be invited from the following groups: the PCMI project, ODI workshop participants, ESEDS workshop participants, NAS workshop organizers, and representatives of professional organizations. (See the draft list of potential attendees in appendix.) Most importantly, participants will also be invited from the administration and faculty of two-year colleges that have started data science programs or are preparing to do so. Additional participants will be invited from industry and academia to ensure an interdisciplinary mix (mathematics, statistics, computer science, engineering), a wide range of industry representatives, and geographical representativeness. We are budgeting for approximately 40 participants.

The engagement of relevant professional associations is key for disseminating the recommendations and resources that result from the summit. In addition to the

American Statistical Association (ASA), the professional associations that we will engage include the following:

Association of Computing Machinery (ACM)
ACM Committee for Computing Education in Community Colleges (CCECC)
American Mathematical Association of Two-Year Colleges (AMATYC)
Mathematical Association of America (MAA)
Institute of Electrical and Electronics Engineers (IEEE)

We will ask that these associations co-sponsor the summit as a show of both support for the summit and a willingness to help with dissemination. This sponsorship would not be financial, except perhaps to cover the expenses of an official society representative at the summit. The ACM CCECC has agreed to help in our dissemination efforts through their website that hosts two-year college curricula in computing.

With its long history of leadership in post-secondary mathematics curriculum development and professional development, the MAA will be engaged in many ways. In addition to the ongoing MAA Special Interest Group on Statistics Education and the standing Joint ASA-MAA Committee on Statistics Education, the MAA currently coordinates the NSF-funded project, "Professional Development Emphasizing Data-Centered Resources and Pedagogies for Instructors of Undergraduate Introductory Statistics" (StatPREP), (Award #1626337). We emphasize this project because it addresses the very important topic of professional development necessary for two-year college faculty to incorporate active exploration of data into existing introductory statistics courses. Since most instructors of introductory statistics are not trained as statisticians and any data science program should have solid statistics instruction, this

professional development program provides an important first step in providing such instructors with? methods appropriate for a data science curriculum.

Products

Two-year colleges are incredibly diverse in terms of the students they serve and the communities in which they are situated. For this reason, a one-size-fits-all approach will not be successful. Each college will face different challenges and needs when seeking collaboration with potential employers, industries, and transfer institutions. However, general principles and guidelines, when backed by professional organizations and researchers and practitioners, can have great impact. Currently there are few resources for planning, no repository, and no guide to help prioritize or evaluate the quality of these resources.

For this reason, we propose producing curriculum guidelines modeled after the PCMI Curriculum Guidelines for Undergraduate Programs in Data Science. This document lists key competencies of a potential data science major, provides a hypothetical course sequence that provides these competencies and, in the appendix, provides detailed content information about these courses. Because the populations served by two-year colleges may be quite diverse, we will produce separate guidelines for associate's degree programs, Four-year Transfer programs, and Certificate programs.

To support the preparation of these guidelines, the summit will be structured in a way that will also lead to producing "white paper" reports on the current state of data science at two-year colleges. These reports will include the needs expressed by

potential employers and four-year transfer institutions, the challenges faced by two-year faculty and administrators, and known existing resources.

Finally, we will produce a summary and guide to resources to assist administrators and faculty at two-year colleges in planning data science degree programs.

Diversity

We will also seek to ensure diversity in the community colleges that are represented at the summit to be consistent with NSF's mission to broaden opportunities and expand participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines. The undergraduate population at two-year colleges has a greater percentage of underrepresented groups than does the population at four-year colleges. For example, the College Board reports that, among all undergraduates at public two-year colleges, 14% are Black and 22% are Hispanic, compared to 11% and 13%, respectively, at four-year public colleges.²² The undergraduate population is also older at two-year colleges, with about 28% age 30 or older (compared to 12% at public four-year colleges). By increasing course offerings in data science at two-year colleges, we can increase the number of opportunities for underrepresented students to enter STEM disciplines.

²² <https://trends.collegeboard.org/sites/default/files/trends-in-community-colleges-research-brief.pdf>.

Outline of Summit Planning

Within a month of an agreement to fund this summit, we will finalize a steering committee composed of seven or eight people representing different communities. The proposed steering committee is

- Rob Gould, Chair (2016-2017), ASA/AMATYC Joint Committee; director, UCLA Center for Teaching Statistics; Professor of Statistics, UCLA, co-author in PCMI Guidelines, participant in ODI Global Data Literacy workshop (will serve as co-chair)
- Mary Rudis, Director of Practical Data Science Program and Professor of Mathematics, Great Bay Community College, Portsmouth, NH (will serve as co-chair.)
- Roxy Peck, Vice Chair, ASA Education Council; Professor Emeritus, Department of Statistics, California Polytechnic State University, San Luis Obispo, CA
- Beth Hawthorne, Chair, ACM Committee for Computing Education in Community Colleges (CCECC); Vice Chair, ACM Education Board; Community college representative to the ACM Education Policy Committee; Senior Professor of Computer Science, Union County College, Cranford, NJ
- Brian Kotz, Professor of Mathematics and Statistics, Data Science Development Team Lead, Montgomery College, Germantown, MD
- Heikki Topi, Principal Investigator, Exploring the Status of Education for Data Science Workshop, October 2015; Professor, Computer Information Systems, Bentley University
- Randy Kochevar, Co-Principal Investigator ODI Pathways for Big Data Careers, Director, Oceans of Data Institute.
- Nicholas Horton, Professor of Mathematics and Statistics, Amherst College, and NAS Data Science Education Roundtable member.

The steering committee's first task will be to outline potential panelists and speakers and to finalize the list of invited participants. (A draft list of potential invitees is included in Appendix A.) The committee will also set the dates for the summit and coordinate speaker schedules. The initial round of invitations for the summit will go out within two months of a positive funding decision.

The summit logistics, support, and other arrangements would be coordinated by the ASA Meetings staff, which has extensive experience in organizing and supporting meetings, workshops, and conferences.

Once the agenda, speakers, and participants are finalized, the steering committee will turn its attention to planning other aspects of the summit, including planning ways to maximize discussion and interactions. We anticipate members of the steering committee and the support staff will have conference calls with the panelists and speakers prior to the summit in order to organize presentations and ensure that they address summit objectives. The steering committee will also organize "working groups" that will produce guidelines, recommendations and resources documents based on the summit discussions. We anticipate that these groups would be composed of steering committee members and summit participants.

Statement on Broader Impacts of Proposed Activity

The proposed summit on data science at two-year colleges has the potential for broad impact that is particularly timely as two-year colleges begin to recognize and address the role that they can play in the development of an educated data science workforce. We believe that there are many opportunities for students who enroll in a two-year college data science program. This summit and its associated workgroups will produce guidelines, recommendations and resources that will help two-year

college faculty and administrators navigate the process of developing an appropriate curriculum and the often complex process of creating new courses and new programs. In this way, it will facilitate development and expansion of programs that address important workforce needs and that can also serve students as a pathway to four-year degree programs in data science.

Two-year colleges, with their diverse student bodies and greater representation from students in groups underrepresented in STEM, can provide an important channel for increasing the diversity of the data science workforce. By establishing data science degree programs, the opportunities for underrepresented students to pursue STEM careers is increased.

The guidelines, recommendations and resources produced by this summit and the associated work groups will be widely disseminated through the relevant professional associations and thus reach members of industry and government, as well as both two-year and four-year college faculty and administrators. We anticipate that we will prepare reports for publication in these associations' journals and newsletters, including *Amstat News*, *The American Statistician* (ASA), ACM CCECC website – <http://ccecc.acm.org> (repository of two-year college curricula in computing), *ACM Inroads*, *MAA Focus*, *AMATYC News*, and *MathAMATYC Educator* (AMATYC). We also anticipate dissemination at national meetings of the relevant professional associations, including at the Joint Statistics Meetings and at the AMATYC Annual Conference.

Timeline/location

The summit will be held in 2018 as early as schedules allow at ASA Headquarters in Alexandria, VA to save costs and so that NSF/OSTP officials may

attend if interested. Representing the profession of one of the foundational disciplines of data science,²³ the American Statistical Association is well suited to host this summit. The ASA headquarters is also conveniently located near the Ronald Reagan National Airport of Washington, DC and its meeting staff has agreements with nearby hotels for competitive room rates. The ASA Meetings staff is also experienced with hosting meetings, workshops, and conferences.

The Steering Committee would be formed within a month of affirmative decision to fund this proposal and all invitations to attend the summit would go out within two months of an affirmative decision to fund this proposal.

Summary

There is growing demand for a workforce with the skills and knowledge provided by data science programs. While such programs are rapidly being introduced at the undergraduate and graduate program level, very few exist at two-year colleges.

This proposal requests funding to support a summit on data science in two-year colleges. This summit and the associated work groups will produce guidelines and recommendations for data science at two-year colleges, as well as provide resources for two-year colleges interested in developing a program in data science.

²³ <http://www.amstat.org/misc/DataScienceStatement.pdf>

Appendix J

GLOSSARY OF DATA ANALYTICS TECHNOLOGIES

This glossary includes general descriptions of common technologies utilized in the fields of data science and analytics to provide an overview of the technical terminology used throughout this paper. The following definitions have been taken directly or modified from the source following each definition. More information can be found on each technology at each reference site.

Term	Definition
Excel	A popular spreadsheet developed by Microsoft that features calculation, graphing tools, pivot tables, and a macro programming language called Visual Basic for Applications. Excel uses a grid of cells arranged in rows and columns to organize data manipulations like arithmetic operations and function. In addition, it can display data as line graphs, histograms and charts. (https://products.office.com/en-us/excel)
Hadoop	Hadoop is an open-source software framework for storing data and running applications on clusters of commodity hardware. The Hadoop framework itself is mostly written in the Java programming language, with some native code in C and command line utilities written as shell scripts. (https://www.sas.com/en_us/insights/big-data/hadoop.html)
Hive	A data warehouse software project built on top of Apache Hadoop for providing data summarization, query, and analysis. Hive gives an SQL-like interface to query data stored in various databases and file systems that integrate with Hadoop. (https://hive.apache.org/)
JMP	A suite of computer programs for statistical analysis developed by the JMP business unit of SAS Institute. JMP software is partly focused on exploratory data analysis and visualization. Design of experiments in JMP remains one of the software's most commonly used features. (https://www.jmp.com/en_us/about.html)

Term	Definition
MapReduce	<p>A programming paradigm that allows for massive scalability across hundreds or thousands of servers in a Hadoop cluster and generating big data sets with a parallel, distributed algorithm on a cluster. MapReduce is a framework for processing parallelizable problems across large datasets using a large number of computers (nodes), collectively referred to as a cluster or a grid.</p> <p>(https://www.ibm.com/analytics/us/en/technology/hadoop/mapreduce/)</p>
Python	<p>An interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level built in data structures, combined with dynamic typing and dynamic binding, make it useful for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together. Python supports modules and packages, which encourages program modularity and code reuse. (https://www.python.org)</p>
R	<p>An open source programming language and software environment for statistical computing and graphics that is supported by the R Foundation for Statistical Computing. The R language is widely used among statisticians and data miners for developing statistical software and data analysis. R provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, ...) and graphical techniques. (https://www.r-project.org/about.html)</p>
SAS	<p>A software suite developed by SAS Institute for advanced analytics, multivariate analyses, business intelligence, data management, and predictive analytics. SAS is a software suite that can mine, alter, manage and retrieve data from a variety of sources and perform statistical analysis on it. SAS provides a graphical point-and-click user interface for non-technical users and more advanced options through the SAS language. (https://www.sas.com/en_us/software/stat.html)</p>

Term	Definition
SPSS	A widely used program for statistical analysis in social science, used for logical batched and non-batched statistical analysis through planning, data collection, analysis, reporting, and deployment. It is also used by market researchers, health researchers, survey companies, government, education researchers, marketing organizations, data miners, and others. (https://www.ibm.com/analytics/us/en/technology/spss/)
SQL	A domain-specific language used in programming and designed for managing data held in a relational database management system, or for stream processing in a relational data stream management system. SQL is designed to query data contained in a relational database. It is a set-based, declarative programming language, not an imperative programming language like C or BASIC. However, extensions to Standard SQL add procedural programming language functionality, such as control-of-flow constructs. (https://www.microsoft.com/en-us/sql-server/sql-server-2016)
Tableau	An interactive data visualization product focused on business intelligence. The product queries relational databases, OLAP cubes, cloud databases, and spreadsheets and then generates a number of graph types using an interactive dashboard. (https://www.tableau.com/products/desktop)