Business Analytics Education: A Latent Semantic Analysis of Skills, Knowledge and Abilities Required for Business versus Non-Business Graduates

Completed Research Paper

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Abstract

Market demand for business analytics (BA) professionals has been skyrocketing in recent years, but challenges arise in developing BA programs. In this study, we seek to uncover the key components of skills, knowledge, and abilities (SKAs) that employers require for this emerging profession by business degree and non-business degree (e.g., computer science, engineering, statistics, mathematics). We used Latent Semantic Analysis (LSA), a text mining technique, to analyze text data of BA position advertisement on LinkedIn, and adopted the educational framework of Bloom’s taxonomy as a sensitizing lens to interpret our results. Our analysis reveals differences in the SKAs for different education: Business graduates are expected to have SKAs in mathematics and BI technologies, while CESM graduates are desired to have business strategy and market knowledge. KSAs are also identified for BA positions that are open to any other academic degrees. Implications on BA program and curriculum design are discussed.

Keywords: Business analytics, business intelligence (BI), IS curriculum, knowledge, skills, latent semantic analysis, LinkedIn

“You are the angel of insight and live for the look on a person’s face when your solutions and analytics transform faceless big data into a crystal ball. Intensely curious and sweating the details, you roll up your sleeves and plunge head first into challenges. You are used to managing strategic projects, but also relish the opportunity to get your hands dirty doing whatever it takes to ensure great project delivery. You think it is about time that banks learn to leverage rich data to better understand their customers. You also have a passion for working hand-in-hand with customers and stakeholders and are as comfortable leading a client meeting as you are structuring analysis.” [Company location: San Francisco, CA; Industry: Information Technology and Services]
Introduction

The opening vignette is an excerpt from a job advertisement for a mid to senior Business Analytics (BA) position. Davenport and Patil (2012) refer to such senior positions in business analytics as data scientists, and call them the “sexiest” jobs in the 21st century. Market demand for BA professionals has been skyrocketing across industries in recent years (Columbus, 2014), but there is a shortage of the qualified candidates for BA positions (Manyika et al., 2011). To take advantage of these job opportunities, colleges and universities have been launching BA degree programs in recent years. According to a recent study by Cegielski and Jones-Farmer (2016), more than 70 BA degree programs have been offered by business schools and other academic departments (e.g., computing, engineering, statistics, and mathematics). However, employers have shown dissatisfaction with the practical BA experience of business graduates (Wixom et al., 2014). Hence, a major question for colleges and universities is how to educate their students to become qualified for business analytics careers?

Recent studies have considered BA degree programs in business schools but have paid little attention to the BA programs housed in other departments. This is not surprising as colleges of business were found more likely to offer BA courses or programs than non-business colleges (Andoh-Baidoo et al., 2014). Yet, there is a lack of consensus on BA-related skills, knowledge, and abilities (SKAs) among business schools (Cegielski and Jones-Farmer, 2016). In a recent review of 44 BA programs from 2009 to 2015, Wang (2015) concludes that there is a lack of an articulated framework of the knowledge domain skill sets for BA professionals.

To fill this gap, in this study, we focus on uncovering key components of SKAs for this emerging profession by considering the educational background required of job candidates. As non-business schools are starting to offer analytics-related degree programs (Cegielski & Jones-Farmer, 2016), we intend to provide some guidelines for program and curriculum design of BA degree programs in both business schools and non-business departments. In particular, we seek to answer the following two questions:

1) What are the SKAs for business versus a CESM (computing, engineering, statistics, or mathematics) graduates?
2) Do the two sets of SKAs differ? If so, how?

To answer these questions, we collected text data of job requirements for 71 unique full-time BA positions posted on a professional networking website (LinkedIn), and analyzed the textual data by using Latent Semantic Analysis (LSA) – a text mining and natural language processing technique. LSA considers not only the word frequency in the textual data but also the contexts in which the particular word is embedded (Sidorova et al., 2008). Thus, it is an appropriate technique for our data analysis, as employers from various industries tend to use different vocabularies to describe the desired BA skills in their BA job posting, thus making the context of the word occurrence more important. To inform our study, we adopted Bloom’s taxonomy (Bloom, 1956; Bloom et al., 1971) – a well-known educational framework – as a sensitizing lens to facilitate the interpretation of our analysis.

Our LSA results show that SKAs for business graduates do differ from those for non-business graduates. Mathematics knowledge, business functional knowledge (finance, accounting, economics) and proficiency in IT productivity tools emerge as the essential SKAs required of business graduates. For candidates with a CESM degree (e.g., computer science, engineering, statistics, mathematics), the most frequently mentioned knowledge for BA positions are business strategy and market knowledge, which is surprising as strategy/market related courses are not a traditional program component of a CESM degree. As our data set includes BA positions that are open to any other academic degrees, we also identified the most expected KSAs for those BA positions without a specific degree requirement. The findings are presented in the Results section and elaborated upon in the Discussion section.

The rest of the paper is organized as follows: we first review the literature and the theoretical framework used for this study. We then introduce LSA and present our results. Finally, we discuss the implications of our findings for BA programs and curriculum design in both business schools and non-business departments and provide directions for future research.
Theoretical Foundations

**Business Analytics and Business Intelligence**

The last decade witnessed the emergence of Business Analytics, referred to as the use of information systems, statistical analysis and predictive models organizational strategic decision making (Davenport and Harris, 2007). Market demand for business analytics workers have skyrocketed across industries. In 2014, the top six industries with significant growth in this demand ranged from Professional, Scientific and Technical Services, Information Technologies, Manufacturing, Retail Trade, Sustainability, Waste Management & Remediation Services, to Finance and Insurance (Columbus, 2014). Not surprisingly, along with the soaring market demand comes the shortage of the qualified candidates for BA positions. According to McKinsey Global Institute, the shortage of skilled analytical professionals is estimated to be between 140,000 and 190,000 (Manyika et al., 2011). This shortage is expected to continue in the coming years. As predicted by International Data Corporation (IDC), “In the U.S. alone there will be 181,000 deep analytics roles in 2018 and five times that many positions requiring related skills in data management and interpretation” (IDC, 2014).

Business Analytics is not a completely new concept to the information systems (IS) field. IS Scholars commonly view BA as an extension of business intelligence, thus referring it as Business Intelligence & Analytics (BI&A) (e.g., Andoh-Baidoo, et al., 2014; Marjanovic, 2012; Wang, 2015). Business intelligence (BI) is a common terminology to “describe the technologies, applications and processes for gathering, storing, and analyzing data to help business users make better decisions” (Wixom and Watson, 2010, p. 14). Over the past two decades, BI technologies have also evolved, from traditional, technologically-oriented focus on ETL (extraction, transformation, and loading) (Elbashir et al., 2008) to facilitating the knowing of users such as allowing users to articulate problems, select data, and make better sense of organizational data (Shollo and Galliers, 2015).

According to Zeleny (2006), BI&A can be traced back the Decision Support Systems (DSS) that were adopted in the late 1960s and continued to grow popular in 1970s and 1980s with the purpose of streamlining business, improving decision making and increasing corporate profits. A paradigm shift in DSS occurred in mid 1990s when the data collected by DSS expanded from internal to external data sources. Meanwhile, the four powerful tools – warehouses, OLAP, data mining, and web-based DSS – help to enhance DSS with objective of not only facilitating decision making at the operational level (e.g., customer purchasing trends, inventory depletion rates, average employee salary, etc.) but also decision making for managerial and strategic benefit (e.g., strategic choices of new store locations, optimal timing of new product offerings and the like) – more commonly referred to as business intelligence (Shim et al., 2002).

BI&A is an important technology continuously rated by IT executives as being among the top three applications and technologies that contribute to the competitiveness of businesses, according to the annual surveys administrated by the Society for Information Management (SIM). The importance of BI&A is demonstrated in two aspects: (1) facilitating and expediting the decision making process; (2) providing future value for organizations in the form of increased sales, profits, and customer satisfaction (Andoh-Baidoo et al., 2014). However, for organizations to realize the benefits from BI&A, organizations must hire employees proficient in BI&A to analyze the large volumes of data from diverse sources and to generate insights from data analysis to guide organizational actions. According to Chiang, Goes, and Stohr (2012), these BI&A practitioners must possess technical skills, analytical skills, and business domain knowledge so as to gather and manipulate data and interpret the analysis results.

Unlike the traditional BI role that focused on purely BI technology, BA professionals, the expanded BI role means that they are expected to possess a diverse set of skills and knowledge. This new BI-related role is challenging, as the level of skills required of this new workforce requires a more holistic approach to business operations and performance (Conway and Vasseur, 2009). Davenport and Patil (2012) consider those BI&A employees as Data Scientists, but they admit that the required talents are hard to find. To differentiate BI&A from traditional BI, in this paper, we use the term “Business Analytics” (BA). Consistent with Davenport and Harris (2007), we define BA as organizational use of information technologies, statistical analysis, and predictive modeling to generate actionable knowledge and intelligence to guide organizational strategic decision making.
**Educational Framework**

Bloom’s taxonomy (Bloom, 1956; Bloom et al., 1971) is a well-known educational framework that offers a systematic classification of learning by cognitive levels. According to this framework, learning occurs at six levels of cognition: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. Originally introduced in the mid 1950s, this framework has been widely used to guide educators’ design of curricula to enhance student learning. With the advancement in cognition and student learning, Anderson and colleagues (2002) revised this taxonomy to include a second dimension: the dimension of knowledge, along with the dimension of cognition. The knowledge dimension includes four types of knowledge: factual, conceptual, procedural, and meta-cognitive.

The following table presents the two key dimensions in the revised Bloom taxonomy and a brief definition of each level (Anderson et al., 2002). Relevant BI&A studies are also included.

| Table 1. Applying Bloom’s Taxonomy to Business Intelligence & Analytics |
|-------------------------------------------------|---------------------------------|
| **The cognition Process**                        |                                 |
| 1-Retrieve                                       | Locating and retrieving mostly factual data |
| 2-Understand                                     | Constructing meaning through instructional materials through processes such as interpreting, summarizing, classifying etc. |
| 3-Apply                                         | Applying a known procedural to a familiar or unfamiliar given task |
| 4-Analyse                                        | Breaking materials into its integrative parts and determining how the parts relate to each other and to the whole through differentiating, organizing, and attributing |
| 5-Evaluate                                       | Making a judgment based on previously acquired knowledge of the relevant standards and criteria |
| 6-Create                                         | Reorganizing the elements into a new structure or pattern |

<table>
<thead>
<tr>
<th><strong>The knowledge dimension</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Factual knowledge</td>
<td>Knowledge of terminology, terms, and facts, which are basic elements of a teaching discipline</td>
</tr>
<tr>
<td>2-Conceptual knowledge</td>
<td>Knowledge of models, framework, classifications, and categories, which enables students to understand the functioning of basic elements in a larger structure</td>
</tr>
<tr>
<td>3-Procedural knowledge</td>
<td>Knowledge of subject-specific method, procedure, algorithms and technique, which describe how to do things</td>
</tr>
<tr>
<td>4-Meta-cognitive knowledge</td>
<td>Learning how to learn, including awareness of one’s knowledge level and one cognitive approach required for different tasks</td>
</tr>
</tbody>
</table>
This framework enables us to align course design with student learning objectives. As Anderson et al. (2002) point out, the majority of course designs (tests and assignments) and questions given to students focus on the lowest level of cognition (e.g., remembering and understanding). However, extant studies on BA programs in business schools suggest that students’ learning tends to focus on advanced cognitive processes from “Apply” to “Create”, and on conceptual and procedure knowledge in relation to the business domain and technologies (e.g., Chiang et al., 2012; Davenport and Patil, 2012; Shim et al., 2002; Wixom and Watson, 2010). Understanding the key knowledge and abilities required of non-business students would allow us to draw a complete picture of BA-related teaching and learning objectives.

Research Method

Data Collection

We collected data on LinkedIn.com during three consecutive weeks in February 2016. According to the Social Recruiting Survey 2013, 94% of recruiters use LinkedIn to post job advertisements and seek job candidates. LinkedIn is the largest professional social network in the world (Hutchins, 2016), thus, it becomes an appropriate context for us to collect a representative sample of BA job advertisements. To meet our research objective, we only included those BA jobs on LinkedIn that met the following three criteria: The posting 1) included the exact phrase “business analytics”; 2) was for a full time position; 3) was the only BA job being advertised by the company. If a company had multiple BA jobs during this three-week period, we only considered one job posting. Doing this allowed us to avoid dependence in the sample and to minimize any bias that might favor larger companies. As a result, 71 unique job postings were collected from 71 different organizations. In most job advertisements, companies indicated the minimum and type of educational degree required.

For all the business-related degrees, such as a BA or BS in accounting, finance, economics, and IS, we categorized those degrees offered by business schools as a “Business Degree”. For those degrees being conferred by other science and technology departments, we classified them as a “CESM Degree” (computing, engineering, statistics, and mathematics). For positions without a specific degree requirement, we coded them as an “Open Degree”. Table 2 below shows the sample statistics, including the total number and percentage of position listings by the degree required of candidates and by the industry concerned.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Industry</th>
<th>Business Degree</th>
<th>CESM Degree</th>
<th>Open Degree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Healthcare</td>
<td>11 (15.5%)</td>
<td>1 (1.4%)</td>
<td>6 (8.5%)</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>Information Technology Services</td>
<td>6 (8.5%)</td>
<td>7 (9.9%)</td>
<td>5 (7.0%)</td>
<td>18</td>
</tr>
<tr>
<td>3</td>
<td>Banking, Financial Services, and Insurance</td>
<td>3 (4.2%)</td>
<td>0 (0%)</td>
<td>3 (4.2%)</td>
<td>6 (8.5%)</td>
</tr>
<tr>
<td>4</td>
<td>Human Resources and legal Services</td>
<td>0 (0%)</td>
<td>2 (2.8%)</td>
<td>2 (2.8%)</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Telecommunications</td>
<td>0 (0%)</td>
<td>3 (4.2%)</td>
<td>1 (1.4%)</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Defense &amp; Space</td>
<td>0 (0%)</td>
<td>2 (2.8%)</td>
<td>1 (1.4%)</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Other Industries</td>
<td>7 (9.9%)</td>
<td>5 (7.0%)</td>
<td>6 (8.5%)</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td><strong>27 (38.1%)</strong></td>
<td><strong>20 (28.1%)</strong></td>
<td><strong>24 (33.8%)</strong></td>
<td><strong>71 (100%)</strong></td>
</tr>
</tbody>
</table>

As shown in the table above, demands for business-educated analytics professionals are slightly higher than those for CESM-trained analysts: 38% and 28.2% respectively. One third of the BA positions do not
mandate a specific degree requirement. The top two industries seeking BA professionals are healthcare, and IT services. In terms of preference by industries, healthcare seemed to prefer business graduates or was open to other educational backgrounds, while IT services sought to fill their BA positions with all types of education background.

**Data Analysis**

As noted, our study adopted Latent Semantic Analysis (LSA) as the data analysis method. LSA is an algebraic-statistical text mining method that can detect the underlying topical structure of a document corpus (Evangelopoulos, 2008). LSA is especially appropriate for this study, because BA is a latent concept that can be associated with many specific vocabularies in a complex manner. Those traditional word-counting text mining methods that only count the word frequency would not work very well in analyzing this type of latent concept. LSA works in a way that is similar to how the human brain works: It distills the contextual meanings of a concept, and identifies the complex structure between a latent concept and its associated words or terms (Evangelopoulos, 2008).

LSA was operationalized as follows in this study. First, we selected the job requirement section of each job posting and put the textual data into a spreadsheet. Then we assigned a unique ID to each of the 71 job postings and grouped them by degree. Each spreadsheet was loaded to Rapidminer 5.0, one of the most widely accepted open source data mining tools. We performed data analysis in the following steps as suggested by Sidorova et al. (2008).

*Pre-processing and term reduction:* 1) all letters were transformed into lower case; 2) the job requirements were then tokenized with non-letter separators; 3) “stopwords” such as “and,” “the,” “is,” “a,” “an” were removed; 4) the term stemming technique was applied, by which the words such as “statistics” and “statistical” that have the same root were combined; 5) all the tokens with less than two letters (i.e., “s,” “x,” and so on) were also removed; 6) the tokens that appeared only in one job requirement were also removed, given their rarity – only being used in an individual posting; 7) tokens such as “abil” and “abl” (as in ability) that refer to only some general concept not necessarily helpful in unpacking the concept “business analytics” were also removed.

*Term frequency matrix transformation:* In this step, the original job requirements were converted into a term frequency-by-document matrix. This matrix shows the number of occurrences that a term appears in a job requirement (a document, in the LSA terminology). However, sound text mining practice does not recommend using this matrix directly (Sidorova et al. 2008). Instead, the matrix was transformed using the TF-IDF (term frequency – inverse document frequency) weighting method (Han et al., 2011; Harman, 1992; Husbands et al., 2001; Salton and Buckley, 1988; Salton, Wong and Yang, 1975). After the transformation, the matrix puts more weight on rare terms and discounts the weight of the common terms.

*Singular value decomposition (SVD):* In this step, the TF-IDF weighted frequency-by-document matrix was decomposed using SVD. SVD is a factorization method. The computation of SVD is discussed in prior literature (e.g., Baker, 2005; Golub and Reinsch, 1970; Klema and Laub, 1980) and is based on a theorem from linear algebra, which states that a rectangular matrix $A$ can be broken down into the production of three matrices – an orthogonal matrix $U$, a diagonal matrix $S$, and the transpose of an orthogonal matrix $V$ (Baker, 2005):

$$A_{mn} = U_{mm} S_{mn} V_{nn}^T$$

where $U^TU = I$, $V^TV = I$, the columns of $V$ are orthonormal eigenvectors of $A^TA$, the columns of $U$ are orthonormal eigenvectors of $AA^T$. $S$ is a diagonal $m \times n$ matrix containing the square roots of eigenvalues from $U$ or $V$ in descending order.

SVD decomposes the TF-IDF weighted frequency-by-document matrix into the production of three matrices, the term-by-factor matrix, singular value matrix, and the document-by-factor matrix. The term-by-factor matrix shows the terms and term loadings that define a particular latent factor. The document-by-factor matrix shows the documents that are related to a latent factor and also the document loadings towards that latent factor. The singular values matrix shows the square roots of eigenvalues of the identified latent factors. A higher singular value indicates a more salient latent factor in the textual data.
Factor reduction: In the previous step, SVD generated 71 latent factors. However, these 71 latent factors are not equally important. Some factors contain more information and some contain less information. The goal of factor reduction is to reduce the number of factors but still retain most of the information in the original text. To reduce the number of factors, one can restrict the matrix $S$ to relatively higher eigenvalues and get a simplified matrix $\tilde{S}_{kk}$ by deleting rows and columns from $S$. For the matrix multiplication to go through, the corresponding row vectors of $U$ and corresponding column vectors of $V^T$ have to be removed and results in another two matrices $\tilde{U}$ and $\tilde{V}^T$. The result looks like this:

$$\tilde{A}_{mn} = \tilde{U}_{mk} \tilde{S}_{kk} \tilde{V}_{kn}^T$$

where $k < \min(m, n)$, $\tilde{A}$ is an approximation the matrix $A$.

Choosing a different $k$ value will give different $\tilde{A}_{mn}$. This is an approximation of the original matrix $A$ and therefore captures more or less “trivial” factors. In this study, the value $k$ was determined by considering how many terms the factors have explained. We used the cut-off line of 90%. For example, the first three non-negative factors have explained 93% unique terms. Therefore, $k$ is equal to 3.

Factor Interpretation: The previous step generated two sets of factor loadings, one for the terms in the term-by-factor matrix and one for the documents in the document-by-factor matrix. Terms and term loadings collective define the latent factors. Thereby, they were used to interpret the latent factors. The interpretation of the identified latent factors is discussed in the following section.

Results

LSA reveals the key differences in the most important SKAs expected from the two degree backgrounds (business versus CESM). When seeking business graduates for BA positions, employers are interested in those business school graduates who are strong in mathematics, knowledgeable about business (finance, accounting, economics), and proficient in IT, ranging from office productivity software to data management and BI technologies. However, for BA positions requiring CESM degrees, the most important SKAs include familiarity with business market strategy and skills in big data-driven technologies. When BA positions are open to any educational background, the most desirable SKAs are related to high-level skills, and enterprise-scope actions and outcome.

Table 3 summarizes the LSA results, including the key factors associated with each educational background. Each factor reveals a unique component of the SKAs required of a BA position. The amount of variance accounted for by each factor is represented by its singular value. The last column lists the high-loading terms, which are truncated lower-case terms resulting from the term reduction process described in the research method section.

<table>
<thead>
<tr>
<th>Table 3. Summary of LSA results and Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factors</strong></td>
</tr>
<tr>
<td><strong>Business Analytics SKAs for Business Degree</strong></td>
</tr>
<tr>
<td>Factor 1</td>
</tr>
<tr>
<td>Factor 2</td>
</tr>
<tr>
<td>Factor 3</td>
</tr>
<tr>
<td><strong>Business Analytics SKAs for CESM Degree</strong></td>
</tr>
<tr>
<td>Factor 1</td>
</tr>
</tbody>
</table>
As shown in Table 3, the major difference in qualification requirements for business versus CESM graduates lies in the scope of business knowledge: business-educated candidates are expected to have a solid functional knowledge (e.g., accounting, finance, economics) and knowledge about business processes and industries, while CESM-educated candidates are required to have high-level knowledge about business strategy and markets. However, the important SKAs for BA professionals, irrespective of background, are competence in database and other data-centric IT and BI technologies.

**Discussion**

**BA Education in Business Schools**

Of all the 71 unique position openings, 27 employers (38% of the total) required their BA job candidates to have a business education background. This is consistent with a prior finding that business schools are more likely than non-business programs to offer BA-related courses and BA degree programs (Andoh-Baidoo et al., 2014). Our analysis highlights that, in addition to business functional knowledge such as finance or accounting, employers expect strong mathematical skills and knowledge of BI technologies from business school graduates.

As shown above, quantitative and IT skills are highlighted in the SKAs for business school educated candidates: multi-skilled business students with an advanced degree (e.g., MA, MS, and MBA) would be preferred by employers seeking BA professionals. If the undergraduate programs and MBA programs continue to offer majors and concentrations in traditional business functions, their graduates would be disadvantaged in the BA job market. To make their BA programs successful, business schools would

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**Table 4: Learning Objectives of BA Programs in Business Schools**

<table>
<thead>
<tr>
<th>Knowledge Domain</th>
<th>Highly Desired</th>
<th>The Cognitive Process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Apply</td>
</tr>
<tr>
<td>Quantitative</td>
<td>mathematics</td>
<td></td>
</tr>
<tr>
<td>Business functions</td>
<td>finance, accounting, economics</td>
<td></td>
</tr>
<tr>
<td>Information technology</td>
<td>web, Oracle, SQL, BI, software packages, system, hadoop, pig, microstrategy</td>
<td></td>
</tr>
<tr>
<td>Organization and industry</td>
<td>bank, health, corporate</td>
<td></td>
</tr>
</tbody>
</table>
therefore need to integrate and emphasize mathematics/quantitative analysis aspects and BI technologies into their curricula (e.g., ‘big data’ analysis, database management).

In addition, business school graduates are expected to develop cognitive abilities in designing solutions, and informing and leading groups, as shown in Table 4. This is reflected from the following excerpt:

“Requires a bachelor’s degree (master’s degree preferred) in business or equivalent, and significant experience in data management, report development and interpretation. May provide work leadership to other associates. 2-3 years of relevant banking experience. Knowledge of banking policies, procedures, practices and documentation. Strong analytical and problem solving skills; excellent written and verbal communication and presentation skills. Ability to work effectively with individuals and groups across the Bank. Proficiency with personal computers and related software packages such as Word and Excel, and other business machines.” [Company location: Northbrook, IL; Industry: Banking and Financial Services; Position level: Mid-senior; Required Education: BA or MA in Business]

**BA Education in CESM**

Our data analysis shows that 28.2% of the total BA position required CESM degrees (as defined above). For graduates of those departments to succeed in the BA job market, they are expected to have organization and industry knowledge, which is seen as an essential qualification (see Table 5 below). This knowledge would therefore be seen to be required to be incorporated into their BA curricula.

<table>
<thead>
<tr>
<th>Knowledge Domain</th>
<th>Highly Desired</th>
<th>The Cognitive Process</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Apply</td>
</tr>
<tr>
<td>Quantitative</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Business functions</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Information technology</td>
<td>imdb, nosql, platform, script, python, language, tool, pig, hadoop</td>
<td>collaborate, discuss, manipulate</td>
</tr>
<tr>
<td>Organization and industry</td>
<td>strategy, market, partner, ecosystem</td>
<td></td>
</tr>
</tbody>
</table>

As shown in Table 5, CESM graduates are expected to develop cognitive abilities in manipulating data, discussing the results of their analyses and collaborating in team project settings. This is reflected in the following excerpt of a position description:

“The Senior Consultant – Business Intelligence Consulting will possess a working knowledge of the airline, travel and/or closely aligned transportation/supply chain business segments. Five plus (5+) years of consulting or client service background. Solid knowledge of RDBMS (Oracle/Teradata/MySQL). Experience in statistical analysis of large datasets (R strongly preferred). Fundamental understanding of the airline business and the ability to translate client business issues into meaningful model representations. Excellent oral and written skills and a commitment to ensuring stakeholders are always advised of project status versus deliverable timetables. Multi-lingual capabilities and extensive international experience are highly desired.” [Company location: Southlake, TX; Industry: Airline and Aviation; Position level: mid-senior; Degree Required: Master’s degree in Computer Science or Statistics. Ph.D. preferred.]

**BA Education in Other Programs**

Of all the 71 unique position openings, 24 employers (33% of the total) did not specify the degree requirement for their BA positions. Overall, positions in this category require comprehensive knowledge (Table 6). It is possible that these ‘open’ positions are looking for candidates with generic SKAs and strong
learning abilities so that they can learn on the job. Further research is needed to investigate the type of industry, role, and position levels related to postings that do not specify degree background.

<table>
<thead>
<tr>
<th>Knowledge Domain</th>
<th>Highly Desired</th>
<th>The Cognitive Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative</td>
<td>quantitative, data</td>
<td>inform, support, mine, persuade, analyze, valuate, proposition, investigate, posit, test, insight</td>
</tr>
<tr>
<td>Business functions</td>
<td>accounting, finance,</td>
<td></td>
</tr>
<tr>
<td>Information technology</td>
<td>application, ERP, IBM, SAP, Excel, BI</td>
<td></td>
</tr>
<tr>
<td>Organization and industry</td>
<td>sale, environ, company, organization, resource</td>
<td></td>
</tr>
</tbody>
</table>

For those BA positions that do not specify require a particular degree qualification, employers have a higher expectation about the breadth and depth of knowledge requirement and a more diverse set of cognitive skills. As Table 6 shows, qualified candidates should be knowledgeable in all four domains: quantitative, business, information technology, organization and industry. The cognitive abilities required are more comprehensive than those required for business or CESM graduates as illustrated below:

**“Analytical Thought”** – In-depth knowledge and experience within business analytics including the building and utilization of financial models. **Leadership** - Experience in direct or indirect leading of a team. **Computer skills** - Experience and proficiency in Microsoft Access and advanced experience and proficiency in Microsoft Excel. **Financial Analysis Experience** – Direct or indirect involvement with business/financial analytics. **Priority and Project Management** - Multi-tasking skills and the ability to balance multiple priorities and keep up with project scope changes. **Teamwork** - Able to work well with both internal and external clients, to include our off-shore team. **Communication Skills** - Solid presentation skills and ability to communicate with various audiences, especially Sales Representatives, Sales Managers, and members of the IT team. Ability to articulate their answer and reasons behind it to a varied audience. **Adaptability** - Quick learner who is easily able to learn new products, systems, applications and market dynamics.

*Company location: Scranton, PA; Industry: Transportation; Required Education: Open*

**Implications for Business Analytics Curriculum Design**

Our analysis reveals some common skills and cognition emphasized irrespective of degree background. Analytical ability, communication and project management skills are deemed to be essential as shown in the following:

**“Your job is to communicate complex data or algorithms into simple conclusions that will empower others to drive action based on the insights you derive. Passionate about Analytics: **Analytic skills** are the foundation of this role. The ability to mine terabytes of data, derive actionable insights, and then translate those insights into business improving action is critical in our work.”** *Company Location: Cincinnati, Ohio; Industry: Consumer Goods*

**“Demonstrated understanding of the managed care industry, health and business trends, and key market issues; Demonstrated sophisticated written and verbal presentation abilities; Substantial experience with the development of presentation materials (collateral, proposals, presentations, talking points, etc.); Proficiency in the management of time, flexibility, and influencing colleagues to meet demanding project timelines;”** *Company Location: Northbrook, IL, US; Industry: Pharmaceuticals*
These results suggest that BA curriculum design should include essential communication skills and cognitive processes, regardless of the schools (business versus CESM) providing the BA degree programs. The common set of SKAs therefore consists of an ability to:

1. interpret business problems and develop appropriate solutions
2. analyze large amount of data from multiple data sources to generate insights
3. communicate effectively (both oral and written) with multiple levels of the organization
4. collaborate with others in a team environment
5. manage projects efficiently and effectively
6. work on multiple projects and with multiple teams.

However, our data analysis shows that distinctive knowledge and skill sets are expected from graduates from different backgrounds: strong mathematical skills are required of business school graduates while marketing and business strategy knowledge are a prerequisite for those with CESM degrees. The LSA results (in Table 3) are somewhat counterintuitive in the sense that, for business school graduates, the most emphasized BA SKAs relate to mathematics (in Factor 1), database, ‘big data’ and BI (in Factor 2) given that mathematics is more prominent in CESM curricula. Database, ‘big data’, and BI are topics that may be considered to be at the intersection between business and CESM. Whereas ‘traditional’ topics taught in business schools, such as business process, organization and industry-specific domain knowledge, are ranked only in Factor 3. The implication is that business school graduates lack CESM backgrounds, and that these skills therefore become the most looked-for skills on the part of employers. Conversely, for CESM graduates, the most emphasized SKAs relate to business strategy and markets (Factor 1) – topics that are taught in business schools. This SKA is emphasized given that CESM graduates tend to lack knowledge in these areas.

Overall, the results of the study imply that neither business school nor CESM BA programs, in their current state, do not completely meet employers’ BA requirements. They each lack something that the other provides. BA programs in business schools tend to lack training in mathematics and other technical areas while those in CESM lack similar training in business studies. Notwithstanding, should we expect business school faculty to offer in-depth mathematics courses given that this is where CESM faculty expertise lies? Conversely, should we expect CESM faculty to offer business strategy and marketing courses?

Scholars have noted the numerous challenges that university educators are facing in BA programs that attempt to meet the skyrocketing industry demands for graduates with the requisite skills (Cegielski and Jones-Farmer, 2016; Wixom et al., 2014). The challenges could be attributed to several reasons, including fast-changing BI content, complex technologies needed in classrooms, and the evolving body of disciplinary knowledge. Focusing on IS departments, Triche and colleagues (2015) propose a skill set based framework that engages the three main stakeholder groups in the emerging data analytics field – the IS department, employers, and IS students – and incorporates coordinated activities to increase the probability of job placements of IS students in the data science profession. Our work complements this study by examining BA job requirements in the marketplace by providing some insight into designing BA curricula across higher education irrespective of discipline. We suggest that, as employers of BA graduates desire complementary skills and knowledge from candidates from business and non-business degree programs, the possibility of a cross-disciplinary approach, such as “Double Majors”, might be appropriate, giving students the required SKAs at an appropriate depth. Such a cross-disciplinary approach would require collaborative effort across higher education (HE) institutions (e.g., IS, business, statistics, economics, operations research, computer science) in the professional development of the future BA workforce. An alternative solution is to adopt an interdisciplinary course enrollment approach such that students of BA programs housed in engineering schools are eligible to register for courses offered in business schools, and vice versa.

**Concluding Remarks**

This study makes a methodological contribution by taking a novel approach of using LSA to analyze text data from job postings. Practically, our results offer guidelines for the development of BA degree programs, which should consider the critical SKAs required in order to better prepare graduates for job
opportunities in the BA field. For example, two panels of experienced researchers and educators have
been held in major IS conferences to share experiences in designing successful BA programs and to
discuss challenges and important tasks concerning the programs’ implementation and sustainability
(Agarwal et al., 2014; Schiller et al., 2014).

It is important to note that our findings should be applied in other contexts with caution, as the study is
limited in two aspects. First, our data sample includes only job postings with the phrase “business
analytics” in the job title. Positions with the title “business intelligence,” “data analyst,” or other such
terminology may refer to BA positions, and should be included in our data sample. Second, the source of
our data collection was the professional networking site (LinkedIn). Job postings on other networking
and/or job sites may call for different skill and knowledge requirements. The study of these may generate
additional insights.

Additionally, as this study is based only on 71 BA job postings LinkedIn, collected over a limited three-
week period, future study based on a larger data set from other social networking and job websites (e.g.,
monster.com and careerbuilder.com) could offer further insights. Moreover, the findings from this study
could be tested by data collected over a longer time period in order to obtain more reliable results. Lastly,
while skilled BA professionals undoubtedly possess key data analytics abilities, their ability to create real
value for their organization will depend on the level at which they operate in their organization, which
would undoubtedly require deeper understanding of the SKAs. In this regard, further study of SKAs for
BA positions at different career stages (junior, middle, or senior) or for different degree levels (graduate
versus undergraduate) would offer additional useful guidelines for organizations to manage the valuable
human resource of BA professionals.

Limitations notwithstanding, this research extends prior BA education research to include BA education
in the science and technology fields. An additional promising future research avenue would be to examine
the offering of BA programs in terms of their learning objectives, and compare these with the SKAs that
are articulated by employers and employees alike. Doing this would allow us to better identify gaps in BA
education provision as perceived by industry practitioners and educators, thereby leading to the
development of BA courses and programs that better meet market demand for this emerging workforce.

Returning to the opening vignette that illustrated what it means to be a BA professional in the eyes of an
employer, we believe that an ideal candidate for such a position cannot simply rely on education based on
traditional, discipline-oriented programs. While it is commonly accepted that meeting the needs of the job
market is key to the success of such programs, our analysis surfaces the different sets of SKAs required of
graduates from business and non-business degree programs, as perceived by the employers of the
graduates, and suggests that professional development of the BA workforce calls for collaborative efforts
across academic disciplines.

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