BIG DATA ANALYTICS THE NEXT BIG LEARNING OPPORTUNITY

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ABSTRACT

The relentless collection of data from user interactions in websites have introduced both a high level of complexity, as well as a great opportunity for businesses. In addition, the trend of connecting not just people, but also machines to the Internet, and then collecting data from these machines via sensors would soon result in an unimaginable repository of data. This ever increasing collection of data, also known as Big Data, will only be useful if it can be analyzed to give useful insights into business problems, and perhaps even to make suggestions as to when and where future problems will occur (predictive analytics) so that the problems can be avoided or at least mitigated.

Students must be prepared take advantage for future opportunities in the field of big data analytics. In most business programs, specifically information system as the major, core course like database design, office applications, and basic programming are taught to learners. A critical component missing from many undergraduate business programs are core courses focusing on data analytics. The US Department of Labor predicts 4.4 million opportunities will exist by 2018, working with data analytics. The imperative to include such courses in business information systems programs exist.

Universities are beginning to notice the great interest in data analysis by organizations, which want data driven solutions to their problems. A few major business schools such as Arizona State University, University of Southern California, and Michigan State University have recently embarked on specialized Business-Analytics graduate Programs, while others such as Northwestern University has no such specialized Programs, but requires all business students to take them. In any case, many employers such as Taco Bell (Yum Brands), General Electric (GE), Boeing, and Walt Disney (Gellman, 2014) are asking for more employees with analytics skills to gain insights from the enormous volumes of data that they collect.

The purpose of this article is to examine the rapidly growing field of Big Data Analytics and to study why and how big data analytics needs to be integrated into business skill sets and curriculum designs. The research will provide a practical framework to design and teach the skills sets needed to solve organizational problems by analyzing the vast amounts of data that are being generated and stored.

This paper will be prove very beneficial to IT educators and academic researchers, as they will gain a solid understanding of why Big Data needs to be an important curriculum component, and the benefits to students and potential employers. Business managers will also benefit from the research as it shows them how new Big Data tools can be deployed to solve

complex business problems, and coax them to encourage universities to incorporate Big Data in their curriculums so that their future employees can compete successfully in an increasing complex, global, inter-connected, data-driven world.

Keywords: big data, technology, analytics, program design, curriculum design, student learning

INTRODUCTION

It is astounding that about 90% of the world's data has been generated in just the last 2 years (SINTEF, 2013). Companies like Facebook, Google, Twitter, and Amazon collect data from interactions and activities by its users. Added to that is yet another new phenomenon known as IoT (Internet of Things), that generates a deluge of data from sensors on equipment and appliances that is even much bigger than what humans create. This ever-increasing collection of data, known often as Big Data, will however, only be useful if it can be analyzed. Analysis will provide useful insights into business problems, and perhaps even make suggestions as to when and where future problems will occur (predictive analytics) so that the problems can be avoided or at least mitigated. Most of the world's big organizations such as Apple, GE, Walmart, Exxon and Samsung have global operations (factories, warehouses, transporters, and customers) and serve several customers with a wide variety of products and services. The complexity of such vast and highly connected networks is hard to unravel, and makes it very difficult for humans to find where and why problems occur.

Data analytics allows businesses to examine large data sets to respond to existing needs in the respective industry of operation. With data being produced continuously by humans and machines, the sheer amount of data available is much more massive than at any time in the past (Hardgrave, 2013). Business analytics is useful for a business to examine patterns and trends in large data sets. Examining the data helps a business generate models for future predictions of patterns and trends. Thus, businesses seek to recruit and hire individuals who understand how to handle large data sets to drive business decision making. This is evident by the increasing demand in the job market for people who have data analytic skills.

Smigala (2014) reports by 2015, 4.4 million jobs will be offered globally to address the needs for big data analysis. Business Schools across the world recognize the need to infuse big data education in the curriculum; however, understanding how to integrate data analysis appropriately in the curriculum presents a challenge. Business Management Information systems courses encourages students to learn how to create and enter data, access data, and generate business reports that can support business decision-making; however, courses offering a specific focus on using data analytics at the undergraduate level seems to be a course educational institutions must examine and integrate in teaching and learning practices.

The purpose of this paper is to briefly describe the nature of big data, highlight its importance in the business world, and make the case for incorporating big data analytics as an essential tool in business and incorporate these tools in university curricula. eCampus News (Barmer, 2014) demonstrates a lack of implementation of data analytic programs in undergraduate curriculums. This research focuses on how undergraduate business schools may help students in higher education gain the big data and data analytics skills and experience necessary to fill the current employment gap of trained professionals in the field.

The Nature of Big Data

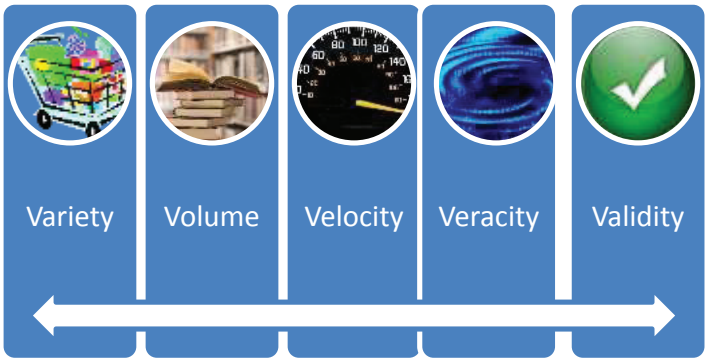
Big data is not just a massive database. Traditional databases store structured data in a table format as shown in Figure 1. In this example, all Employee data records are stored as rows in a table with 6 columns for each Employee, hence, the data is referred to as "structured". Structured data can be easily processed by modern database management systems such Oracle, DB2 and SQL Server and using languages such as SQL.

Figure 1: Example of Structured Employee Data

Employee Name	Id	DOB	Department	Email	Tel#
Bean L	1234	11/22/1960	Accounting	Bean@xyz.com	111-222-3333
Peas G.	2234	4/5/1970	IT	Peas@xyz.com	111-333-2222
…					

Big data, however, is often unstructured. The data source can be generated by humans or by machines. Examples of human generated unstructured data include Microsoft Word

Figure 2 Big Data Dimensions



documents, "text" messages from cellphones, posts in Facebook and Twitter, or web pages of companies or individuals. Examples of machine-generated data could be "location" information from mobile phones, sensor information from automobile engines, satellite images, and video clips from surveillance cameras. It is just not that big data is unstructured, but the rate of data generation is fast, and the volume of data that is generated is massive – the business challenge is to rapidly analyze these mountains of data in order to generate actionable insights. The fact that big data is generated with little direct control at the source also brings into question the very veracity (quality, accuracy etc.) of the data, and hence making the results of data analysis questionable at times. Another aspect of big data is validity - how valid is the data for analyzing a problem, and if there is an expiration data after which the data is not that valuable. In summary, the five important dimensions of big data are shown in Figure 2.

The proliferation of big data, by itself, is not useful. The real benefits lie in analyzing the data and using the patterns they reveal in making decisions – the discovery of actionable insights. Big data infrastructure comprises of a big data repository, data analytics software, and the data scientists. Data scientists use their domain knowledge and expertise in the growing field of data sciences, which need strong mathematical, statistical, and information technology. As stated before, the whole idea is to sift through the mountains of data, and get actionable insights.

Tools for Big Data

Traditional relational database management systems are not efficient, nor effective in handling big data due to its unstructured nature and high volume. A new class of systems such as Apache Hadoop and NoSQL data stores are far more suited to big data. Hadoop is an open source platform for storing and processing big data on a cluster of inexpensive servers. Hadoop is highly scalable as demand varies, and is very resilient from failures due to its built-in redundancy. It is also very efficient in processing big data over parallel processors using the Map/Reduce technique pioneered by Google. The cost savings of a Hadoop system versus the traditional systems are staggering - instead of costing tens of thousands of dollars per terabyte, Hadoop based computing and storage capabilities costs just hundreds of dollars per terabyte (Nemschoff, 2013).

NoSQL (Not only SQL) data stores are popular methods to store data on Hadoop servers because certain types of queries are much faster to compute, and are easier to formulate than using traditional SQL on Relational databases. Unlike SQL, however, there is no standard NoSQL database, and several types are available – each having advantages depending on the type of big data problem being solved. Some popular NoSQL databases are Cassandra, Hbase, Apache CouchDB, MongoDB, Dynamo and Neo4J.

Hadoop and NoSQL databases make up the infrastructure to maintain and process big data. A plethora of new big data analytics software vendors are now emerging to take make sense of all this big data and gain some deep insights in order to make rapid, effective decisions. Some of the major Analytics software vendors include SAS, Palantir, Qlik, Splunk, Jaspersoft, Platfora, and Sumo Logic. Some other vendors such as Tableau and Zoomdata specialize on building dashboards and data visualization tools to visually appealing graphics for easier and more effective understanding of large volumes of data, and hence leading to better decision making.

Many of the traditional large IT vendors such as SAP, Microsoft, HP, IBM also have their own built in tools for big data Analytics. Given the rapid growth of big data and the need to manage and analyze it, it is clear that Information Systems curriculums need to be quickly updated in order to impart these vital technology skills.

The Big Data Advantage in Decision Making

A big part of managers' duties is to make decisions. In traditional decision making (see Figure 3) managers' knowledge about the situation (via reports from traditional IT systems and business intelligence), skills, past experiences, biases, innate intelligence, and intuitions are some important factors in making effective decisions in a timely manner. A good dose of luck also plays an important part, as there is much uncertainty about external factors. Organization's hire

the best managers possible based on their past successes, and hope that they can use their history of good decisions to make excellent future decisions as well. As we can see, there is a lot of

Figure 3 Traditional Decision Making

subjectivity in this kind of decision-making process, and it is largely based on past experiences of decision makers.

With the advent of real time big data from sources such as web data, customer data, operational data, machine data and so forth, managers suddenly have a data-driven tool to help make smarter decisions (Lo, 2014) that are based on more objective, actual events (represented by real-time big data streams) and deep insights into them (analytics software and data scientists). There is less reliance on subjective managerial inputs and past experiences due to the availability of real time deep insights from big data to make decisions more data-driven. The overall "luck factor" and "external uncertainty" is also diminished, thus leading to potentially better decisions. Figure 4 depicts "smarter and data driven," managerial decision-making in the big data World.

Figure 4 Smart and Data-Driven Decision Making Using Big Data

As we have seen, big data analytics is potentially a new, powerful decision making tool that can be leveraged by managers. We shall now look at some practical applications of big data. Cyber security is increasingly becoming a major problem for many organizations, and the traditional method was generally to keep the "bad guys" out of the systems. Many of the current security breaches reveal that it is almost impossible to keep hackers out of a network, so it has become essential to do real time monitoring and analysis of all the network event data generated by customers, employees, business partners, public actors, and even other machines. The volume

of data generated by event logs is huge – for example, the automobile portal website Edmunds.com experiences 50,000 events per minute and produces 60 to 70 gigabytes of data per day (Splunk, 2014). In order to analyze and make sense of all this big data, Edmunds uses a Splunk based software solution. Spulnk Analytics software not only look for security breaches, but also analyzes consumer behavior on Edmund.com's web site, and also looks for issues that could damage company image (say, via social media posts). In summary, Splunk big data analytics generates real-time alerts for real-time decision-making. It also provides hourly, daily, weekly, and data for historical analysis.

With regards to cyber security, a smarter technique using big data is currently being developed - a "risk-based" approach that lends itself to cost/benefit analysis, manage risks, and expected outcomes. Big data is used for risk assessment of IT Assets, and investment decisions to secure IT systems are made accordingly. Hence, it is important to find of probability of breach and the severity of the loss as well. Behavioral Analytics of big data of network events makes this possible. It is, therefore, critical that IT and business students get familiar with the newer managerial techniques using big data analytics.

Demand for Trained Big Data and Data Analytics Professionals

The advent of data from multiple streams require trained professionals to analyze, describe, and predict the current or future consumers' needs for a business based on the data collected and stored in an organization. Preparing for opportunities to work with big data is increasing. In 2014, the top ten big data employers (see Figure 5) created 10,318 jobs (Columbus, 2014).

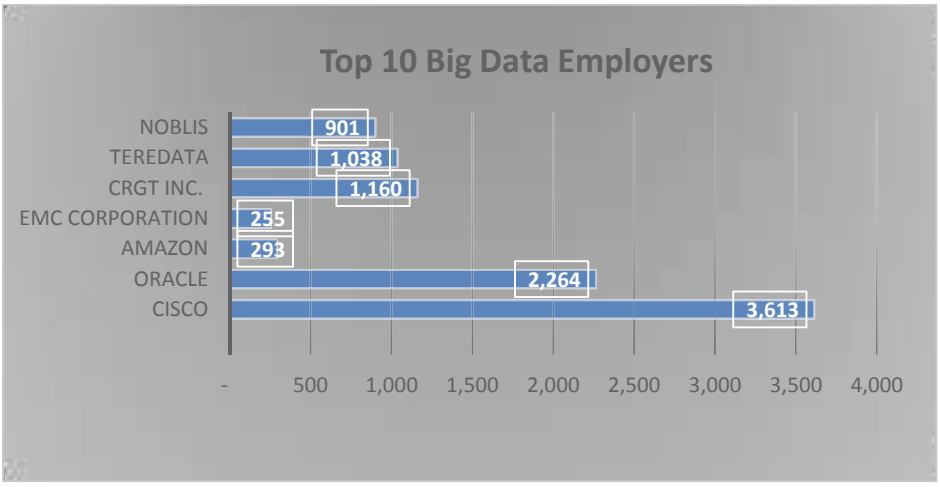


Figure 5 Big Data Positions Created in 2014

Based on current predictions, job growth potential in the big data field is very positive. Projections for 2015 suggest the creation of about 1.4 million jobs data analytics field in the

United Stated. A gap in qualified candidates to fill those positions will likely range from 140,000 to 190,000 by 2018 (Figure 6). It is imperative that undergraduate schools examine their curriculums to understand what the institution can do to prepare students for careers in the industry. (Lazar, 2012)

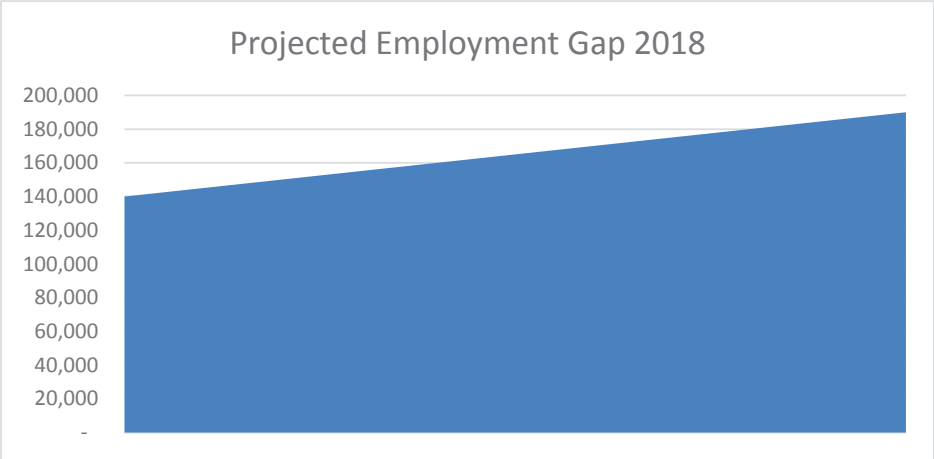


Figure 6 Gap in qualified Big Data Analytics applicants in 2018

Big Data Integration in Business Education Curriculum

To integrate big data in the curriculum, information systems curriculum designers should be familiar with what students need to know. Many business school programs offer an introduction to big data within existing database courses; however, a greater need exists to develop courses to addresses the current gaps in educating students to meet big data skill demand in industry. These new courses will incorporate core big data concepts and analytics techniques in the IT curriculum.

Universities are beginning to notice the great interest in data analysis by organizations, which want data driven solutions to their problems. A few major business schools such as Arizona State University, University of Southern California, and Michigan State University have recently embarked on specialized Business-Analytics graduate Programs, while others such as Northwestern University has no such specialized Programs, but requires all business students to take them. In any case, many employers such as Taco Bell (Yum Brands), General Electric (GE), Boeing, and Walt Disney (Gellman, 2014) are asking for more employees with analytics skills to gain insights from the enormous volumes of data that they collect.

The current projection by (Lazar, 2013) is that by 2018, the United State will have a shortage of 140,000 to 190,000 skilled personnel to perform data analytics jobs. Educators can prepare to address this gap by designing a curriculum to address the demands of the current marketplace (Ferguson, 2014). Knowing how to manage, analyze, and report results from analysis of large data sets will support an organization in making decisions on products to market, coupons to offer, or services to be rendered fulfilling an exceptional need for businesses trying to compete in a global economy. In addition, Integrating appropriate learning objectives in the curriculum helps keep the learning relevant and students prepare for challenges they will face in their careers working with data (Ferguson, 2014).

Graduate school is where big data programs are appearing most often to prepare excessive demand for data scientist. In fact, the first domestic master's program in analytics offered was at North Carolina State University in 2007 (Bengfort, 2013). Arguably, as the demand increased new programs were developed to fill the gaps. The list of the top 10 graduate programs were identified by eCampus News (Sharnoff, 2013). Most of the top graduate big data programs were developed in business schools such as Bentley University-Waltham, Drexel University, Louisiana State University, Massachusetts Institute of Technology, and New York University. Each program shared a common theme in most of the curriculums, teaching students real-world application of big data and analytics to help businesses make effective business decisions (Sharnoff, 2013).

Few undergraduate business programs offer a major in big data programs. These include Drexel University, Southern New Hampshire University, and Arizona State University. A recent undergraduate data analytics program in the United States was launched at Ohio State University (Barmer, 2014), which seems determined to meet the demands of businesses. The program at OSU recognizes the impact big data can have across the curriculum. To address the dynamic need for the business industry, Ohio State will be offering the program as an interdisciplinary degree from medicine to the arts (Barmer, 2014). The program is nestled in their Discovery Themes Department, whose focus is on answering global questions surrounding the environment, technology, and social issues. This program is the first of its' kind and the long-term goal is to recruit 500 teaching and tenured/tenure track professionals. (Box-Steffensmeir, Riffe, Hoy, et al, 2014)

Educators Preparation for Big Data Instruction

To facilitate learning of data analytics in educational settings course instructors should investigate the tools and resources needed to implement big data in the curriculum. Educators have to make the learning real and relevant to learners to address the current gap in industry with a need for trained professionals to mash-up and analyze data to respond to the demands of the market. Industry communicates an extensive need to make intelligent decisions based on volumes of data available (Hardgrave, 2013, Ferguson, 2014). Institutions of learning must adapt teaching and learning in information science and systems programs to respond to address the predicted need. The exact strategy to refine teaching and learning experiences for students will likely emerge from examining existing models and by evaluating the programs that are currently being implemented.

Teaching big data in the classroom can be a daunting task if the teaching tools are missing from the learning experience. An essential tool needed to teach data analytics is having access to big data sets. To address this issue Tacit a technology news leader suggest building partnerships with businesses (Admin, 2013). Another approach to getting access to data would be to invest in purchasing vendor software that includes data sets or to search for universities' that provide access to data sets (Flood, 2013, Watson, 2013).

Identifying businesses, universities, or vendors to provide datasets to facilitate learning in the course will support students with gaining hands on experiences working with data and analyzing data sets (Admin, 2013). Having access to data sets will help students analyze small or large data sets (Topi, 2013, Watson, 2013). Students will likely have classroom opportunities to explore scenarios and to conduct analytics of data sets when institutions collaborate with businesses, universities, or vendors willing to share data to facilitate student learning (Topi,

2013). The University of Arkansas is one such institution of learning who willingly shares data sets (Watson, 2013)

Getting access to data sets is a foundation for preparation to teach students how to work with big data to understand its impact on commerce; however, software must be identified to hone analytic skills. Watson (2013) offered several powerful tools instructors could explore to support analytics of data. Tableau is data analytics software (Topi, 2013, Watson, 2013). This tool can be used to analyze to data sets and to develop awareness of data visualization. Hyperion, SAS Enterprise Miner, and Cognos are vendor software tools available at no cost or an affordable rate. Each tool offers case studies and research reports to support student development of big data analytics (Watson, 2013).

Teredata University Network offers free online learning. (Watson, 2013). Faculty can use the repository of resources on the site to teach student data analytics skills. Data sets are included for student use to make the learning experiences rich and practical to what student would likely anticipate experiencing in the real world. This online training tool offers certification courses. Organizations look favorably on the opportunity hire students who enter the workforce with certifications.

Big Data Curriculum

Database skills are a skillset that instructors in business information technology instructional programs believe are important to career readiness. The use and teaching of big data traditionally aligned with teaching students how to use Excel and Access to enter, access, and pull data. With the emergence of big data and analytics, some believe that educators need to do a better job of teaching students how to deal with data (Ferguson, 2014). Revamping the curriculum is a necessity to teaching big data. This initiative is supported by President Obama's administration who announced a push for a Big Data Research and Development Initiative (Lazar, 2012). The announcement of this initiative has evoked conversations about how to teach and leverage big data and analytics in the business world. For the purpose of this research, the researcher will focus on how to develop the curriculum to teach data analytics. This section will answer the question of what the curriculum should include.

Big data Professor Fouladkar purports the existing curriculum dealing with data instruction should be redesigned to move from a focus on an extensive list of data collection, entry, and reporting (e.g. sales numbers for a reporting period), to a visual tool that will provide peaks and low points of sales during a reporting period (Ferguson, 2014). This new design approach demonstrates how big data can provide opportunities for further analysis beyond knowing the numbers and crunching the data to create more opportunities for data analysis.

Hardgrave (2013) offers three areas should be studied "big data, analyzing data, and making decisions using data. Analytics professor Watson (2013) offers the notion that three kinds of analytics exist and that academic studies developed should produce students for careers in industry when learners have an understanding of descriptive, predictive, and prescriptive analytics. These three kinds of analytics necessitate skill development and readiness to manage, analyze, and interpret large and small data sets to make business decisions (Hardgrave, 2013, Topi, 2013, Watson, 2013).

A program that focuses on descriptive analytics will challenge students' critical assessment what has occurred. Students will have the opportunity to explore scorecards, dashboards, reporting, and online analytical processing (OLAP) and data visualization. This

learning strategy will teach students to critical assess business and performance management strategically (Watson, 2013).

Another program area a student may consider educational training is in predictive analytics. Predictive analytics sets forth a critical assessment of what will happen in the future. The student will engage in factor and regression analysis. Effective implementation of this process the learner will need training in demand forecasting, customer segmentation analysis and fraud detection (Watson, 2013).

In addition to the other programs of, instructors should consider is designing the curriculum to teach prescriptive analytics skills. Learning prescriptive analytics will train the learner to focus on what should occur. The learner who develops in this area of analytics will engage in advocating revenue management. Industries that need analytics in this focused area of learning are airlines, hotels, and businesses who sell perishable goods (Watson, 2013).

The question remains as to how to introduce business education students to big data concepts in a business education program. Mathematics and Statistics programs will lead the way in the development of programs and tools used to analyze data (Frydenberg, 2014). However, business education schools have the opportunity to teach students how to analyze and use the most appropriate data analytic tools garnered to support a business working with big data. An early introduction to big data the curriculum is most practical (Frydenberg, 2014).

Business education programs engagement with big data offers opportunities to prepare students for the demands of industry through training on "analyzing and interpreting complex organizational data (Topi, 2013 pp. 12, p5)." Exposure to "storage space, processing power, Internet connectivity, security, and ways to access or update information online" becomes the foundation to preparation for a big data curriculum (Frydenberg, 2014, p. 2, p7, Topi, 2013). Students' learning includes the use of standard MS Office software such as Excel or Access depending on the size of the data set the instructor uses with students (Frydenberg, 2014). Tableau Software is available free to higher education institutions (Flood, 2013). Other highly recommended tools are Hadoop, Python, R, or RSuite. Keep in mind the professors' instructional time will likely increase when introducing command driven tools like R or R Studio when learners are inexperienced with programming and command driven learning tools (Columbus, 2014, Hill & Kline, 2014).

Established prerequisite courses students complete prior to entry into a big data course should include statistics, calculus, and programming. Each will reduce apprehension and anxiety students may experience when learning to work with big data (Hill & Kline, 2014).

Offering courses in big data will likely support students in gaining the insights into the volume, velocity, veracity, and validity of big data by working with real data sets (Admin, 2013, Frydenberg, 2014) Unstructured data sets are available accessible for use for educational purposes at no cost. Salient data collected from students confirms students will gain practical real-world experience, increasing readiness to meet the needs of a potential employer (Frydenberg, 2014).

Ethics, Privacy, and Legal Issues

Curriculum development includes development of hard skill sets and soft skill sets. Developing students' ability to analyze data is a hard skill. Instruction is incomplete without inclusion of lessons that support development of soft skills too. One such soft skill as it relates to working with big data is ethics. Including ethics in the curriculum supports awareness of how to

avoid being overly intrusive when gaining access to data sets from sources such as Twitter, Facebook, or other social media feeds. Additionally, it helps students learning ethical implications for misuse of private information.

Addressing the ethical issues associated with data analytics curriculum is a necessary component to teaching data analytics. Ethics touches every facet of a business organization. Privacy, too, is an important aspect of ethical use of data. Access to big data allows the analyst to be very intrusive and predictive of consumer behaviors. The data collected will provide descriptive information from a variety of data sets. Data sets can come from a variety of sources such as text, social media, and the internet (Chessell, 2014).

Consumers provide access to this information by agreeing to allow businesses to track them through following them through text, social media outlets, and tracking on the internet. Agreeing to share information does on give the business permission to market products or services based on personal discoveries. One such example given by Sterrey (2014) is releasing a marketing campaign based on gathering data that predicts a "health care concern or pregnancy." Figure 7 is an ethical awareness framework that helps an organization analyze and develop policies on how to analyze and use data collected (Chessell, 2014).

The chief concern of instructors teaching big data courses is to embed in the course the legal and ethical standards employees must follow by understanding what a business can legally do with data collected versus what the company may desire to do with the data. Data can be used legally, but it still may not be an ethical use of that data. Students, therefore, need exposure to real case studies dealing with ethics, privacy, and legality. Students also need to be aware that there is such a thing as "too much information privacy" when manipulating and analyzing data as well. There is often a tradeoff between profits and ethical use of data.

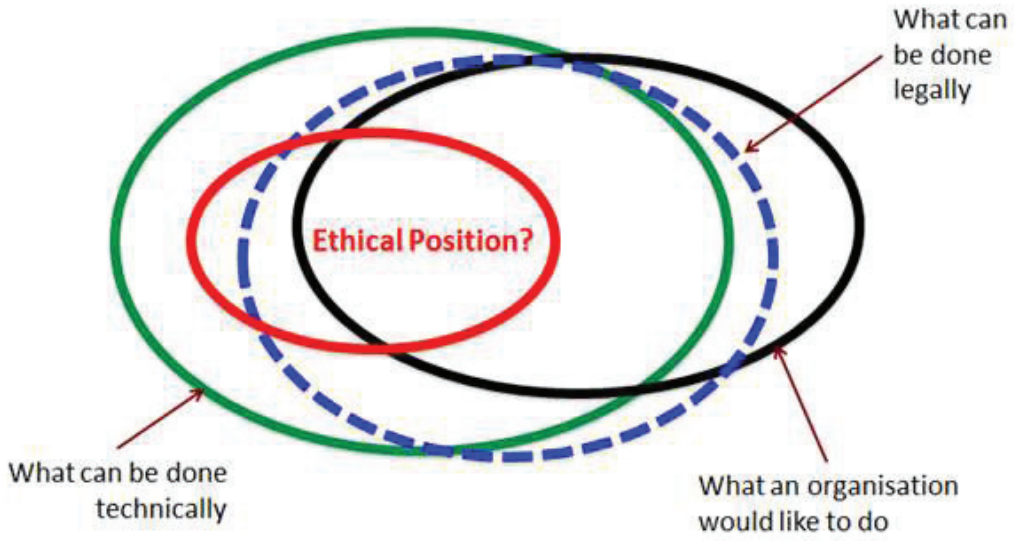


Figure 7 Ethical dimensions of Data

Summary and Conclusion

It is clear that big data is a powerful tool in the corporate arsenal, and that students need to be well versed in its effective use. Businesses need data scientists who have received expert training to shift through the data and find the untold stories embedded in the data. What is

understood is that businesses need to understand that multiple streams of data contribute positively to the businesses bottom line.

A big data gap exists in undergraduate education, and institutions of learning must respond to the needs of businesses to help students gain the requisite skills to meet the unmet needs of businesses. This research provides a practical framework to design and teach the skills sets needed to solve organizational problems by analyzing the vast amounts of data that are being generated and stored. The end goal for this research is to explore and develop appropriate educational tools and curriculum designs needed to prepare students to manage, manipulate, and analyze massive data sets to help business make intelligent decisions purely on data analytics.

Preparing undergraduate students to manage the data flows and to use applications to create visualizations of what the data is saying from a business sense translates into a student prepared to help organizations anticipate and respond to consumer needs. Educators seeking online resources to understand the latest developments with designing big data courses will increase familiarity and preparation to design appropriate learning curriculums for students. Interaction on educational socially networked sites can support the development of creative instructional strategies for teaching students how to leverage social media for use in the business world. Further research is needed to understand whether the course design prepares students for the demands of business at an undergraduate level.

In summary, big data is here to stay as the volume and velocity of the data is going to increase. It is imperative that educational programs are developed to teach students what big data is, why it is needed, and the real world applications of how big data and analytics transform business decision making. The legal and ethical elements of how data is used and shared are extremely important to prevent students from mishandling the data and putting an organization at risk for public embarrassment or experiencing legal ramifications. This research presents a strong case for development of curriculum content to help students learn how to prepare for careers requiring big data and data analytic skills.

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