AN EXPLORATORY EFFORT INTO A DECISION SUPPORT MODEL FOR GUIDING SKILL DEVELOPMENT BASED ON AN ANALYSIS OF CURRENT EMPLOYMENT OPPORTUNITIES IN INFORMATION TECHNOLOGY

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Education plays an important role in the preparation of the future job force. When educators become more informed as to the skills and responsibilities expected of their students when they enter the job force, the educators can react and develop curriculum to help sharpen those desired skills. Public job postings can give an insight into the world of the future for the students--what skills are in demand, what occupations will be available, and what growth potential exists in the industry.

This study will explore the creation of a new methodology using the Bureau of Labor Statistics (BLS) employment projections in combination with public job postings to determine the growth of skills in the information technology industry. A skill category index will be created using public job postings of different information technology occupations. The skill requirement index is then referenced against the BLS employment projections and potential areas of skill growth can be determined.

The results of this new methodology show that it can be a practical and inexpensive way to understand the skills required in the not too distant future. This study

deepens the understanding of skills employers expect from their job candidates and which skills may be best for educators to help students form, develop, and hone.

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CHAPTER I

THE PROBLEM AND ITS BACKGROUND

Statement of the Problem

The current economy has started shifting toward a knowledge-based economy where speed, interconnectivity, and information dominate. There can be little doubt that the development of Information Technology (IT) is a driving factor to an era of creation and expansion. For this reason, the identification and training of well-trained IT professionals is central to the business organization of today. However, many companies are having difficulty in finding completely qualified candidates (Lee, 2003).

Information technology is a field filled with ever evolving employment opportunities. This nebulous employment definition means that university-level IT programs need to remain in a state of constant update in order to ensure that their graduates compete in the global IT market. As the latest and greatest technologies emerge and the field adapts, the skills that employers seek updates and grows (Topi et al., 2010).

Many people have studied the skills associated with IT jobs using various techniques such as focus groups, interviews, surveys, and job posting analyses. The studies tended to focus on the current market, and did not attempt to create any prediction of a future job market state. The studies also focused on technical skills, while simply mentioning humanistic and business skills as on the rise. Because the skills themselves

are what allow an employee to solve a problem and are what is valuable to an employer, this thesis will focus on and predict the skills' growth, rather than job growth.

Definition of Terms

1. Skill Category is the largest group of skills, broken into the three categories of humanistic, business and technical skills.
2. Skill Set is the second largest grouping of skills. These sets are larger than individual skills and fit into the larger skill categories. For example, programming is a technical skill category, but Java programming is an attribute under the skill set of programming.
3. Skill Attribute is the smallest and most specialized of skills. These are typically the skills that would be found on a resume.
4. Job Category is defined as a large grouping of similar jobs as outlined by the Bureau of Labor Statistics.
5. Technical Skills are those that require specialized knowledge, which would typically be taught in an information science curriculum.
6. Humanistic Skills as those skills that deal with human interactions in any environment and intrinsic qualities of the individual.
7. Business Skills as those skills that are used in a business environment and can help the individual progress in their chosen career.

Purpose of the Study

The worlds of academia and business should not exist on their own solitary islands. Academia should help prepare students appropriately for success in their future career path and business should support the development of their future employees. This

analysis will aid in creation of more empirical link between academic programs and the skills required from employers. This goal of this thesis is to develop a method of analysis that will reduce costs, decrease the time, and maintain the accuracy of similar studies of the job market with the added benefit of creating a prediction of how the market will change in the future. This thesis methodology can become a decision support in crafting new courses, guiding program/course decisions, recruitment, and resume emphasis.

CHAPTER II

REVIEW OF RELATED LITERATURE

This literature review will examine the need for a decision support model related to skills taught in education programs. The review will begin with an analysis of the types of skills that employers typically look for when reviewing job candidates. It will continue with a discussion over the employment gap that employers are finding in their newly graduated hires and a desire to find completely competent and qualified individuals. The review will discuss how data mining and text analysis techniques can be brought into this problem and how it has worked in the past. Lastly, the Bureau of Labor Statistics (BLS) predictions and categorizations are discussed in order to link job postings with the future and with career occupations.

Importance of Information Technology Skills

The importance of skills in the IT profession has been researched for many years (Duke and Williams, 1999; Gallagher et al., 2010, Lee et al., 1995, Lee et al., 2008; Leitheiser, 1992). The studies have used a variety of methods, which include the analysis of job postings, surveys, focus groups, and interviews with hiring professionals (Arnett and Litecky, 1994; Gallivan et al., 2002; Gallivan et al., 2003; Litecky et al., 1996; Prabhakar et al., 1996; Todd et al., 1995). In one study, Lee et al. (2006) found that humanistic skills were found to be more important to new hires than technical skills.

While Abraham et al. (2006) and Gallagher et al., (2010), found that business skills were far more likely to be retained in house while technical skills were more likely to be outsourced. With findings placing similar importance on business and humanistic skills, Plice and Reinig (2007) found that technical skills helped graduates in the short term, while business and humanistic skills were relevant over the long term. In 2005, Prabhakar et al. found that the most important technical skills were web programming, Unix, Java, C++, and SQL programming. However, in 2010 Lee and Mirchandani found that the technical skills associated with wireless communication and applications, mobile commerce application, web applications, and IT security were the fastest growing skills.

Currently, the IT industry is growing; it is showing an impressive growth rate and a low unemployment rate when compared to other industries (Hein, 2015; Pratt, 2014). In 2014, Pratt and ComputerWorld conducted a survey polling IT hiring executives about the skills they predict they will be seeking for new jobs in 2015. It was found that the most in-demand sets of skills are programming and application development skills, and particularly, the development skills that can handle the scale and complexity larger companies. Pratt found that project management was a skill that was the second highest in-demand, as companies catch up due to lack of investment in skilled project managers in the past. Technical support skills came in third, as the variety of software and hardware that companies develop, and then have to support, grows and expands. Security and governance made it to number four in the ComputerWorld survey as headline-making security breaches convince executives to spend more money on security (Pratt, 2014).

In a related survey, Hein analyzed Dice.com's job postings to find the fastest growing skills (2015). Hein discovered that the fastest growing skill is cybersecurity. As

the Internet of Things expands, the potential for abuse expands, and this causes an increase for the need of cybersecurity. This was followed by a proficiency in an automation tool, Puppet, to help automate the roles of system administrators. Third, big data skills are desired in order to extract actionable and useful information from the large stores of information that companies already have, or can gather. Fourth, and fifth of the fastest growing skills are big data skills of Hadoop and NoSQL respectively, only emphasizing that there is a desire to use big data and gain an advantage big data may be able to provide (Hein, 2015). The IT industry desires change and grows as technology changes and grows. Having a clear understanding of the skills the IT industry desires can aid in the decision-making process of which skills to teach.

Types of Skill Categorizations

The one aspect of all of the studies on the skills is clear and that is the requirements for the job skills are fluid. What was the most important skill of its day is being replaced as disruptive technologies arrived in the technology world and the skills associated with the old technology decline. Technical skills are changing and university-level education needs to change with the times or fall behind (Hopi et al., 2010). The humanistic skills, which were not as important in the mid 1990's, are becoming more important as the technologies becomes more mainstream and the technical skills, although important, become more commonplace (Hardin et al., 2002).

The skill sets associated with Information Technology jobs has been widely researched. (Bailey and Mitchell, 2006; Cappel, 2002; Cheney and Lyons, 1980; Lee et al., 2008; Lee et al., 2002; Lee and Lee 2006; Liu et al., 2003; Nelson, 1991; Plice and Reinig, 2007; Prabhakar et al., 2005; Shah and Martin, 1997; Todd et al., 1995; Whitten,

2008; Young and Lee, 2997) However, there has been little to no consensus regarding the knowledge, skills and abilities that IT professionals deem essential at any particular time. This is most likely due to the nebulous nature of the information technology field as a whole (Havelka and Merhout, 2012). As a consequence broad and abstract categories will be used for skill classification in this research.

The attributes will be sorted into larger skill sets. The skill sets and attributes categorization was adopted from the categorizations proposed by Huang et al. (2009). Huang et al. (2009) analyzed over 100 articles discussing IT skills and then grouped the skills into three larger categories: humanistic, business and technical skills. Humanistic skills are the skills that represent enduring concepts of personality and serve as a cornerstone for overall job effectiveness and success. Business skills are those in a particular business area or company-specific knowledge. Finally, technical skills are the skills associated with the knowledge and use of technology (Huang et al., 2009). In the end there have been very few points of consensus when it comes to the most important skills in IT. In general, the humanistic and business skills tend to be emphasized in IT literature while the practitioner research emphasizes technical skills. However, job postings seem to include all three skill sets, humanistic, business and technical skills fairly evenly. (Huang et al., 2009) This indicates that the broadest, most well-balanced picture could be found in job postings.

Employment Skill Gap

There are a number of studies, which indicate that there exists a gap in the skill sets and knowledge required by the IT industry versus academia. (Cappel, 2002; Kim et al 2006; Lee and Fang, 2008; Tang et al., 2001) Many researchers claim that IT

educational programs do not always align with the requirements of the business world. (Tang et al., 2001; Lee et al., 2000; Weber et al., 2001) A survey conducted in 2006 by Kim et al., concluded, that project management, security, Enterprise Resource Planning (ERP) and soft skills should be given more emphasis than they were given according to the IS 2002 model curriculum. In 2008, Lee and Han focused on job postings for the programmer/analyst in Fortune 500 websites. While in Lee and Han's (2008) study both industry and academia agreed that social and business skills, application and software development were important, they found that there was a gap concerning the problem-solving skills, knowledge of technological trends, and knowledge of business functions. Asheim et al. (2009) surveyed IT managers and faculty members on the importance of various skill sets related to an entry-level IT professional. While there was much in agreement on the importance of interpersonal, technical, and organizational experience, there was a disparity in the importance of hardware concepts, operating systems and work experience. This gap, whatever form it takes, can do nothing but hinder industry in finding suitable candidates from the IT graduate pool and hinder IT graduates from finding suitable careers. This means that someone needs to keep an eye on the changing technology and job market in order to better facilitate filling the market demand.

Data Mining

In order to close the gap between industry and academia, a quick, accurate and efficient method for determining the state of the industry is needed. A questionnaire of IT professionals, be it a focus group, a survey or interview, would be accurate, but take months, and would be a significant effort to analyze the results. Only a repetitive analysis of job postings can automate at the level needed to quickly, accurately and efficiently get

results. The amount of information available on the Internet is staggering. Traditional data warehousing techniques lack the ability to handle the large volume of data that a venture of this magnitude can offer (Ali and Kokun, 2010). Techniques such as web mining can be used to analyze this information (Berry and Linoff, 2000; Huang et al., 2009). The relatively newer technology, data web mining, can offer the throughput and the ability to sift through the often-useless amounts of data that typically is associated with analyzing job postings (Zhong, 2008). In order to effectively count and analyze the skills required of a job posting, the data mining technique of text mining should be used. In text mining, each job post is searched for terms that correlate to a specific skill and a count of the results is attained (Smith and Ali, 2014). Sobhi and Son (2010) suggest that concept mining can be used to study the job trends in the industry and by using a hierarchal structure of related keywords one is able to categorize the trends in the industry. Creating a method for quick, accurate and efficient analysis of the job market in the IT industry, IT academia can begin to close the perceived gap, helping both their graduates and the industry.

Bureau of Labor Statistics

Data-web mining will only go so far. It will quantify the current skill set requirements. To create predictions of the future, market projections need to be used. IT literature uses the BLS projections and employment numbers, as a method for employment analysis (Aasheim et al., 2012; Wright, 2009). The Bureau of Lab Statistics (BLS) creates projections of job categories on a semi-annual basis. The most current version of these projections, the 2012-2022 projections, will be used. On average, the BLS projections tend to perform better than the naive model of projections, which lends

the use of these numbers credibility (Wyatt, 2010). The skills can be used in conjunction with the projections to monitor skill set projected growth. This will enable universities and businesses to analyze and interpret the growth of skills rather than courses.

Table 1

Bureau of Labor Statistics 2012-2022 Employment Projections

Job Category	2012 Employment	2022 Employment	Percent Change (%)
Computer and Information Research Scientist	26,700	30,800	15.30
Computer and Information Systems Managers	332,700	383,600	15.30
Computer Hardware Engineers	83,300	89,400	7.40
Computer Network Architect	143,400	164,300	14.60
Computer Network Support Specialist	174,600	186,800	6.90
Computer Operators	74,600	62,000	-17.00
Computer Programmers	343,700	372,100	8.30
Computer Science Teachers, Postsecondary	41,700	47,000	12.70
Computer Systems Analysts	520,600	648,400	24.50
Computer User Support Specialists	547,700	658,500	20.20
Database Administrators	118,700	136,600	15.10
Information Security Analysts	75,100	102,500	36.50
Network and Computer Systems Administrators	366,400	409,400	11.70

The BLS publishes a list every year of the current state of the job market broken down by industry, and job categories. Every ten years, the BLS publishes a similar list of the current status plus predictions of where that status will be in ten years. This is called the employment projections (Bureau of Labor Statistics, 2014a). Table 1 shows the 2012 employment numbers and the predicted values for 2022 employment numbers.

Bureau of Labor Statistics Occupations

The Information Technology field changes over time; new careers are created with emerging technologies. The BLS puts out an Occupational Outlook

Handbook, which describes occupational categories and states information regarding the requisites of each occupation (Bureau of Lab Statistics, 2015b).

Table 2

BLS Job Category Descriptions

Job Category	Description	Education
Computer and Information Research Scientist	Invent innovative uses for existing technology and designs new approaches	Doctorate
Computer and Information Systems Manager	Plan and coordinate efforts on information technology projects	Bachelors plus certification
Computer Hardware Engineer	Design, develop and test new computer systems and components	Bachelors
Computer Network Architect	Design and build networks	Bachelors
Computer Network Support Specialist	Service and maintain networking infrastructure	Associates
Computer Operator	Monitor computer equipment and hardware	High School
Computer Programmer	Create code for computers to follow	Bachelors
Postsecondary Educator	Educate college and university students and conduct original research	Masters or Doctorate
Computer Systems Analyst	Organize computer systems and processes more efficiently	Bachelors
Computer User Support Specialist	Handle customer complaints and provide support for users for software	High School
Database Administrator	Store, organize and support databases for an organization	Bachelors
Information Security Analyst	Create, develop and support the cyber-protection for an organization	Bachelors
Network Computer System Administrator	Ensure reliability and operation of a computer system	Bachelors

In the Occupational Outlook Handbook, job titles are organized into categories. It is these categories that will be used in this study. These job categories are defined in Table 2.

Summary

The full realization of many of the potential areas of data science has yet to be determined. One growing area of data science is text mining. Text mining can be used on any area of text-based communication to determine patterns when placed into a larger context. By using text mining on job posts in the area of information technology, one is able to create a quantified analysis of skills that employers desire in their applicants. This method can be used cheaply and efficiently to monitor changes in the job market and the skills associated with those jobs.

Using the Bureau of Labor Statistics projections with the snapshot generated by this methodology, one will be able to create predictions on the jobs and skill sets needed in the future. This can become a decision support model for academia in developing courses and projects to include humanistic and business skills, which have largely gone ignored in most recommendations for curricula in IT. This will better inform the decision makers of today of the possibilities in the future.

CHAPTER III

RESEARCH DESIGN

Research Design and Procedures Overview

In this chapter, a discussion takes place on the methodology of how to answer the question of which skills are in demand. It begins with how to collect the data of job postings, including from where they were collected. It continues with an explanation of how the indexes for the text mining were generated.

The purpose of this study is to use currently advertised employment opportunities to determine the most desired skills employers are seeking in candidates and to create a methodology for creating a predictive model on how these skills might change in the future. The study obtained quantitative information about the skills typical for BLS IT job categorizations through the processes of data web mining and text analysis.

Collection of the Data

In order to gather the necessary list of employment opportunities a web crawler was written and employed against CareerBuilder.com. CareerBuilder.com has one of the largest databases of job postings in the United States and one of the highest numbers of unique users in the job aggregation market.

Methodology

A single threaded web crawler was written using a combination of HtmlUnit and jsoup libraries. HtmlUnit was used as a headless browser in order to interact with the

search box element of the website, thereby using CareerBuilder.com's own search engine to aggregate the results for each BLS job category of jobs posted in the last seven days across the United States. Once the results were generated from CareerBuilder's search engine, jsoup was used to navigate and collect the web pages' bodies from the search results, indexing them by the job category. The web crawler was run twice once on November 5, 2014 and the second during on November 25, 2014.

Advantages and Disadvantages

The benefit from using HtmlUnit was its ease of implementation. It allowed for typical HTML ids and CSS selectors to be used. Jsoup excels at navigating links, which is why it was then employed to scrape the search results.

Using CareerBuilder.com to find jobs provided many benefits. First, it allowed jobs from all across the United States to be queried. Second, CareerBuilder.com already uses the BLS job categorizations to categorize jobs. This allowed for a larger certainty of retrieving relevant information when using BLS job categorizations as search terms. Lastly, CareerBuilder is one of the most popular job websites in the market today, this allows for a substantial database of unique job postings.

There was one prime disadvantage to using CareerBuilder as the sole source of the data. First, no site is going to be complete in all jobs available. A sizable amount of companies, particularly the Fortune 500, do not use a service like CareerBuilder, opting instead to keep that functionality in-house; Caterpillar, State Farm, Google, IBM and Microsoft are prime examples of this fact.

Analysis of the Data

Once the job postings were collected, an index of key terms needed to be generated to create a skill list for each job posting. This resulted in an indexed list of skills as they relate to job categories. The index list was compared to the job postings and a table relating jobs to skills began to take form.

Methodology

A small utility program was written to search the job postings. The body of the job posting was stored in a MySQL database and a generated list of key terms was used to search the body of each job posting. Manually reading three hundred job postings and categorizing skills listed in those posts by key terms generated the key terms list. After all the job postings were analyzed using this list, a random sample of fifty job postings was manually analyzed again. This process was repeated again in batches of fifty job postings until the randomly selected job postings did not yield any new key terms for skills. The presence of terms, rather than the frequency in the job postings, was taken into account.

Advantages and Disadvantages

The advantage was that this method kept the number of job postings that needed manual reading to a manageable level.

One obvious disadvantage to this process was that the key term list could be missing terms. Another disadvantage was that only a very small percentage of the job postings collected were analyzed 450 out of 40,817, which is about 1.10% of the total.

Measurements

Once the job postings were collected and indexed based on skills in the postings, the information was normalized based on the number of jobs the BLS indicated were

available for each category (See APPENDIX A). Normalization was used in determining how prevalent a particular skill was and how the skill growth was calculated. This normalization was conducted using the weighted percentile method.

CHAPTER IV

ANALYSIS OF THE DATA

Analysis of Types of Skills

In this chapter, the data will be revealed. It begins with the analysis of the skills and the over all frequency of those skills in the information technology job market. The analysis continues with each BLS occupation and shows the breakdown of the skill sets for that occupation.

Skills that are listed in a job post were analyzed through key terms and phrases that indicate a particular skill. This data gives a glimpse into the minds of the employers and what skills they were looking for in a potential candidate.

Skill Categories

A total of 40,817 job postings were collected over the month of November. Each time only job postings seven or fewer days old were considered. These job postings were analyzed (Table 3). The most often mentioned skill category was technical skills with 99.64% of job postings mentioning a technical skill at least once.

Table 3

Job Postings Per Skill Category

Skill Set	Frequency (N)	Percent (%)
Humanistic	38,930	95.38
Business	38,214	93.62
Technical	40,671	99.64

Technical skills were followed by humanistic skills with 95.38% and finally, business skills with 93.62% of job postings. Of particular interest was the apparent lack of a technical skill being mentioned in 139, or 0.36%, of job postings. Of this 0.36% of job postings, 121, or 87.05%, were Computer and Information Systems Managers, where the job post was primarily focused on business and humanistic skills, instead of technical skills.

Skill Sets

The job postings were then analyzed based on skill sets, which fall into the three skill categories. Table 4 shows the breakdown of the different skill sets.

Table 4

Job Postings Per Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	30,938	75.80
Interpersonal Skills	31,110	76.22
Basic Work Skills	31,804	77.92
Business		
Business Communication	6,082	14.90
Business Interpersonal	23,828	58.38
Business Work	25,998	63.69
Business, Others	27,440	67.23
Technical		
Operating Systems	19,710	48.29
MS Office	12,734	31.20
Business IT Solutions	21,229	52.01
Networking	10,584	25.93
System Skills	34,386	84.24
Programming	9,675	23.70
Database	19,873	48.69
Project Management	18,521	45.38
Web Development	5,131	12.57
Security	10,530	25.80
ERP	7,820	19.16
Service Computing	8,926	21.87

The skill set with the largest percentage was system skills at 84.24%, while the smallest was web development at 12.57% of all job postings. Interestingly, both are technical skills. Humanistic skill sets were, on average, the most consistently mentioned in job postings, even if they were not the most frequent of the skill categories mentioned.

Skill Attributes

Skill attributes are the smallest breakdown of skills from skill sets. For the humanistic skill category (Table 5), the skill sets, from largest to smallest, are basic work skills, interpersonal skills, and then communication skills.

Table 5

Job Postings Per Humanistic Skill Attributes

Skill Set	Frequency (N)	Percent (%)
Basic Work Skills		
Proactive	14,277	34.98
Dependable	9,812	24.04
Adaptable	13,989	34.27
Ability to handle ambiguity	14,296	35.02
Ability to work under pressure	8,860	21.71
Open to new experiences	5,018	12.29
Creativity	3,363	8.24
Critical thinking	12,389	30.35
Interpersonal Skills		
Work in teams	14,838	36.35
Negotiation skills	9,231	22.62
Leadership skills	21,278	52.13
Ability to learn and teach others	14,172	34.72
Communication Skills		
Reading Comprehension	24,583	60.23
Written Communication	29,987	73.47
Oral Communication	26,939	66.00

In the basic work skills, the most frequently mentioned skill attribute is ability to handle ambiguity, with 35.02%. The least often mentioned is creativity, with only 8.24%. Among interpersonal skill set, the largest was leadership skills, with 52.13%, and the smallest was negotiation skills, with 22.62%. Lastly, the communication skill set most often required written communication (73.47%) skills and least often mentioned reading comprehension (60.23%).

Table 6 shows a breakdown to skill attributes from skill sets for the skill category of business skills. The business skill attribute that was most often explicitly mentioned in job postings was ethics and professionalism, with 60.37% of job postings. While the least mentioned skill attribute was the skill of understanding organizational culture and politic with only 3.94% of job postings mentioning it.

Table 6

Job Postings Per Business Skill Attributes

Skill Set	Frequency (N)	Percent (%)
Business Communication		
Presentation skills	14,277	34.98
Business Interpersonal		
Customer relations	23,801	58.31
Business Work		
Analytic ability	23,801	58.31
Problem solving	16,283	39.89
Understand business environment	10,782	26.42
Knowledge of business functions	8,935	21.89
Ability to learn business functions	7,655	18.75
Understand organizational culture and politic	1,608	3.94
Business, Others		
Ethics and professionalism	24,642	60.37
Global awareness	7,181	17.59

Technical skills is the largest category with the most number of skill attributes. In Table 7, the breakdown of technical skill sets is shown. Systems development and design are the two largest skill attributes that were mentioned in job postings with 63.35% and 57.03% respectively. Multiple factor authentication was the least mentioned with only 34 postings out of 40,817 specifically mentioning this skill.

Table 7

Job Postings Per Technical Skill Attributes

Skill Set	Frequency (N)	Percent (%)
Operating Systems		
Microsoft OS	16,781	41.11
Linux / Unix	6,059	14.84
MS Office		
Word	10,108	24.76
Excel	8,673	21.25
Business IT Solutions		
Business process analysis / design	2,379	5.83
Application development	18,298	44.83
Integrating business applications	3,958	9.70
Networking		
LAN/WAN	7,971	19.53
Setting up networks	5,895	14.44
Wireless networks	2,666	6.53
System Skills		
Gathering system requirements	3,588	8.79
System analysis	17,419	42.68
UML	1,511	3.70
System design	23,277	57.03
Systems development	25,857	63.35
System auditing	4,948	12.12
Programming		
COBOL	255	0.62
C#	2,484	6.09
JAVA	5,584	13.68
.NET	2,347	5.75

Visual Basic	1,939	4.75
HTML	2,319	5.68
XML	1,125	2.76
Database		
SQL	11,029	27.02
ORACLE	1,751	4.29
Data Mining	1,979	4.85
Database Management	12,732	31.19
Data warehousing	1,913	4.69
Sharepoint	1,983	4.86
Project Management		
Project Planning	8,613	21.10
Project Budgeting	16,320	39.98
Project Risk Management	11,598	28.41
Web Development		
Mobile Development / Responsive Design	836	2.05
Ruby on Rails	113	0.28
PHP	920	2.25
HTML5	1,941	4.76
Web 2.0	2,557	6.26
Security		
Multiple Factor Authentication	34	0.08
Penetration Testing	301	0.74
Application/Network Security	7,742	18.97
Access Management	3,750	9.19
Enterprise Resource Planning		
SAP	301	0.74
Oracle Business	7,742	18.97
Siebel	3,750	9.19
Service Computing		
Cloud Computing	3,795	9.30
SOA (Service Oriented Architecture)	1,461	3.58
Business Modeling	4,850	11.88

Analysis of Employment Categorizations

The 40,817 job postings that were collected were separated into the BLS job categories. The two more frequent job categories, as seen in Table 8, were Information Security Analysts, with 6765 job postings and Computer and Information Systems Managers, with 6613 job postings. Interestingly, there was only one Computer Science educator job posting found through the analysis, which is too small of a sample size to do further analysis. This seems to indicate that Computer Science Teacher job postings are not posted on CareerBuilder.com.

Table 8

Job Postings Per Job Category

Job Category	Frequency (N)	Percent (%)
Computer and Information Research Scientist	568	1.39
Computer and Information Systems Managers	6613	16.20
Computer Hardware Engineers	4758	11.66
Computer Network Architect	1455	3.57
Computer Network Support Specialist	1955	4.79
Computer Operators	2459	6.03
Computer Programmers	2095	5.13
Computer Science Teachers, Postsecondary	1	0.00
Computer Systems Analysts	5220	12.79
Computer User Support Specialists	3046	7.46
Database Administrators	5433	13.31
Information Security Analysts	6765	16.57
Network and Computer Systems Administrators	449	1.10
Total	40817	100.00

Computer and Information Research Scientist

Table 9, shows the skill set breakdown for the job category of computer and information research scientist. By far the most mentioned skill was systems skills, which were mentioned in 93.13%, indicating an almost mandatory skill for the career. The least mentioned skill was security, seeming to indicate that security was typically not an issue that computer and information research scientists pay attention to during their development process.

Table 9

Computer and Information Research Scientist Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	447	78.70
Interpersonal Skills	479	84.33
Basic Work Skills	477	83.98
Business		
Business Communication	107	18.84
Business Interpersonal	297	52.29
Business Work	391	68.84
Business, Others	409	72.01
Technical		
Operating Systems	175	30.81
MS Office	172	30.28
Business IT Solutions	294	51.76
Networking	70	12.32
System Skills	529	93.13
Programming	138	24.30
Database	352	61.97
Project Management	214	37.68
Web Development	106	18.66
Security	12	2.11
Service Computing	43	7.57

Computer and Information Systems Managers

Computer and information system managers seemed to require interpersonal and system skills the most, with 86.80% and 83.38% respectively. Web development did not seem to be a skill that a computer and information systems manager needed, with only 9.75% of job postings mentioning this skill (Table 10).

Table 10

Computer and Information System Managers Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	5,455	82.49
Interpersonal Skills	5,740	86.80
Basic Work Skills	5,466	82.66
Business		
Business Communication	1,397	21.13
Business Interpersonal	4,140	62.60
Business Work	4,560	68.96
Business, Others	4,555	68.88
Technical		
Operating Systems	3,030	45.82
MS Office	2,324	35.14
Business IT Solutions	3,819	57.75
Networking	1,516	22.92
System Skills	5,514	83.38
Programming	1,162	17.57
Database	2,678	40.50
Project Management	3,957	59.84
Web Development	645	9.75
Security	1,279	19.34
Service Computing	1,219	18.43
Operating Systems	1,523	23.03

Computer Hardware Engineers

The skill attribute most often mentioned in a computer hardware engineer job posting was system skills with 88.76%, while the least mentioned was service computing with 9.58% (Table 11).

Table 11

Computer Hardware Engineers Scientist Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	3,057	64.25
Interpersonal Skills	3,002	63.09
Basic Work Skills	3,623	76.15
Business		
Business Communication	468	9.84
Business Interpersonal	2,197	46.17
Business Work	2,431	51.09
Business, Others	3,345	70.30
Technical		
Operating Systems	2,741	57.61
MS Office	972	20.43
Business IT Solutions	2,262	47.54
Networking	2,037	42.81
System Skills	4,223	88.76
Programming	1,507	31.67
Database	1,867	39.24
Project Management	1,687	35.46
Web Development	926	19.46
Security	1,974	41.49
Service Computing	456	9.58
Operating Systems	1,089	22.89

Computer Network Architect

Table 12 indicates that for job postings of computer network architects, system skills were mentioned the most often with 95.25% of jobs postings listing the skill, and business communication was the least mentioned skill having only 14.09% of job postings mentioning it as a requirement.

Table 12

Computer Network Architect Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	1,104	75.88
Interpersonal Skills	1,161	79.79
Basic Work Skills	1,171	80.48
Business		
Business Communication	205	14.09
Business Interpersonal	761	52.30
Business Work	869	59.73
Business, Others	989	67.97
Technical		
Operating Systems	812	55.81
MS Office	257	17.66
Business IT Solutions	1,008	69.28
Networking	724	49.76
System Skills	1,386	95.26
Programming	576	39.59
Database	724	49.76
Project Management	724	49.76
Web Development	386	26.53
Security	464	31.89
Service Computing	277	19.04
Operating Systems	620	42.61

Computer Network Support Specialist

A computer network support specialist job posting most typically mentioned communication skills with 84.30%, and least often mentioned web development skills with only 7.42% (Table 13).

Table 13

Computer Network Support Specialist Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	1,648	84.30
Interpersonal Skills	1,579	80.77
Basic Work Skills	1,492	76.32
Business		
Business Communication	389	19.90
Business Interpersonal	1,447	74.02
Business Work	1,346	68.85
Business, Others	1,512	77.34
Technical		
Operating Systems	885	45.27
MS Office	649	33.20
Business IT Solutions	852	43.58
Networking	1,011	51.71
System Skills	1,478	75.60
Programming	210	10.74
Database	546	27.93
Project Management	704	36.01
Web Development	145	7.42
Security	551	28.18
Service Computing	155	7.93
Operating Systems	469	23.99

Computer Operators

In Table 14, the skill sets for the job category of computer operators is shown. This table indicates that basic work skills were mentioned the most often with 81.50% and knowledge about operating systems was the least mentioned with 5.49% of job postings.

Table 14

Computer Operators Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	1,952	79.38
Interpersonal Skills	1,872	76.13
Basic Work Skills	2,004	81.50
Business		
Business Communication	339	13.79
Business Interpersonal	1,486	60.43
Business Work	1,421	57.79
Business, Others	1,280	52.05
Technical		
Operating Systems	935	38.02
MS Office	1,174	47.74
Business IT Solutions	793	32.25
Networking	354	14.40
System Skills	1,651	67.14
Programming	262	10.65
Database	541	22.00
Project Management	837	34.04
Web Development	182	7.40
Security	103	4.19
Service Computing	344	13.99
Operating Systems	135	5.49

Computer Programmers

Computer programmer job postings typically included system skills, with 90.12% of job postings stating this skill attribute as a requirement. The least often mentioned skill was business communications with only 8.07% of job postings listing it. Interestingly, programming was not the most often skill set mentioned. While being at a solid 60.19%, there were a number of skill sets more prevalently mentioned, for example, basic work skills (70.31%) and databases (63.01%) (Table 15).

Table 15

Computer Programmers Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	1,443	68.88
Interpersonal Skills	1,449	69.16
Basic Work Skills	1,473	70.31
Business		
Business Communication	169	8.07
Business Interpersonal	891	42.53
Business Work	1,184	56.52
Business, Others	1,083	51.69
Technical		
Operating Systems	1,051	50.17
MS Office	458	21.86
Business IT Solutions	1,094	52.22
Networking	244	11.65
System Skills	1,888	90.12
Programming	1,261	60.19
Database	1,320	63.01
Project Management	682	32.55
Web Development	585	27.92
Security	240	11.46
Service Computing	472	22.53
Operating Systems	338	16.13

Computer Systems Analyst

In Table 16, the skill sets for the job category of computer systems analyst is shown. At the top, 90.42% of job postings mentioned system skills. At the bottom, only 11.19% of mention web development as a requirement.

Table 16

Computer Systems Analyst Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	4,030	77.20
Interpersonal Skills	3,914	74.98
Basic Work Skills	3,976	76.17
Business		
Business Communication	844	16.17
Business Interpersonal	2,989	57.26
Business Work	3,802	72.84
Business, Others	3,220	61.69
Technical		
Operating Systems	2,143	41.05
MS Office	1,695	32.47
Business IT Solutions	3,000	57.47
Networking	738	14.14
System Skills	4,720	90.42
Programming	1,308	25.06
Database	2,763	52.93
Project Management	2,470	47.32
Web Development	584	11.19
Security	975	18.68
Service Computing	1,289	24.69
Operating Systems	1,178	22.57

Computer User Support Specialists

A computer user support specialist job posting most often listed communication skills as a highly desired skill set with 86.44% of job postings mentioning it. Least mentioned was web development as a desired skill set (Table 17).

Table 17

Computer User Support Specialist Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	2,633	86.44
Interpersonal Skills	2,540	83.39
Basic Work Skills	2,186	71.77
Business		
Business Communication	378	12.41
Business Interpersonal	2,487	81.65
Business Work	2,083	68.38
Business, Others	2,153	70.68
Technical		
Operating Systems	1,613	52.95
MS Office	1,015	33.32
Business IT Solutions	1,717	56.37
Networking	1,319	43.30
System Skills	2,317	76.07
Programming	548	17.99
Database	1,133	37.20
Project Management	1,088	35.72
Web Development	301	9.88
Security	921	30.24
Service Computing	430	14.12
Operating Systems	986	32.37

Database Administrator

Database administrator job postings most often listed database skills as desired at 92.78%. The least desired skill was business communication at only 14.58% (Table 18).

Table 18

Database Administrator Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	3,910	71.97
Interpersonal Skills	3,978	73.22
Basic Work Skills	4,384	80.69
Business		
Business Communication	792	14.58
Business Interpersonal	2,854	52.53
Business Work	3,327	61.24
Business, Others	3,352	61.70
Technical		
Operating Systems	3,237	59.58
MS Office	1,718	31.62
Business IT Solutions	2,729	50.23
Networking	1,127	20.74
System Skills	4,245	78.13
Programming	1,007	18.53
Database	5,041	92.78
Project Management	2,447	45.04
Web Development	648	11.93
Security	926	17.04
Service Computing	1,632	30.04
Operating Systems	1,008	18.55

Information Security Analyst

In Table 19, the skill sets for the job category of information security analysis are listed. Systems skills being the most desired with 89.40% of job postings mentioning it as a requirement. Web development was the least mentioned skill with only 8.47% of job postings desiring this skill.

Table 19

Information Security Analysts Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	4,961	73.33
Interpersonal Skills	5,089	75.23
Basic Work Skills	5,117	75.64
Business		
Business Communication	1,099	16.25
Business Interpersonal	3,988	58.95
Business Work	4,374	64.66
Business, Others	5,219	77.15
Technical		
Operating Systems	2,747	40.61
MS Office	2,211	32.68
Business IT Solutions	3,401	50.27
Networking	1,504	22.23
System Skills	6,048	89.40
Programming	1,641	24.26
Database	2,939	43.44
Project Management	3,491	51.60
Web Development	573	8.47
Security	2,839	41.97
Service Computing	1,501	22.19
Operating Systems	1,355	20.03

Network and Computer Systems Administrator

Network and computer systems administrator job postings most often mentioned the systems skill set with 87.53%. They least often mentioned business communication as a requirement with 6.24% (Table 20).

Table 20

Network and Computer Systems Administrator Skill Set

Skill Set	Frequency (N)	Percent (%)
Humanistic		
Communication Skills	297	66.15
Interpersonal Skills	309	68.82
Basic Work Skills	363	80.85
Business		
Business Communication	28	6.24
Business Interpersonal	263	58.57
Business Work	206	45.88
Business, Others	322	71.71
Technical		
Operating Systems	340	75.72
MS Office	88	19.60
Business IT Solutions	234	52.12
Networking	290	64.59
System Skills	393	87.53
Programming	69	15.37
Database	219	48.78
Project Management	219	48.78
Web Development	53	11.80
Security	246	54.79
Service Computing	67	14.92
Operating Systems	132	29.40

Reliability of Results

Cronbach's alpha is a measurement of internal consistency reliability. Typically, Cronbach's alpha is used in survey studies to show that an item in a survey is relevant to the construct being measured by correlating the responses to questions. However, in this

study, Cronbach's alpha was used to verify the accuracy of the text mining. The output from the text mining was grouped by job categories. If the output showed a high correlation between the skill attributes and the job postings for each job category, then it could be considered that there was internal consistency. The internal consistency indicated that the actual job postings retrieved for a given job category referenced similar positions.

Table 21

Internal Reliability

Job Category	Mean Skills	Sum of the Variance	Standard Deviation	Cronbach's Alpha
Computer and Information Research Scientist	15.54	9.03	5.14	0.67
Computer and Information Systems Managers	15.95	9.22	5.49	0.70
Computer Hardware Engineers	13.61	8.58	5.24	0.70
Computer Network Architect	16.53	9.69	5.81	0.72
Computer Network Support Specialist	14.47	8.36	4.85	0.65
Computer Operators	11.96	7.56	5.45	0.76
Computer Programmers	13.86	8.87	6.13	0.77
Computer Systems Analysts	15.33	9.13	5.59	0.72
Computer User Support Specialists	15.44	8.93	4.71	0.61
Database Administrators	14.71	8.85	5.99	0.76
Information Security Analysts	14.97	9.06	5.49	0.71
Computer and Information Research Scientist	14.87	8.75	5.90	0.76

This should show that a particular job category is internally consistent and can be considered a group. For an exploratory study, a high value is considered to be 0.8 and an acceptable value is above a 0.6 (Hassad, 2009). Table 21 outlines the internal reliability

statistics of the study. The lowest Cronbach's alpha was 0.61 for computer user support specialists, and the largest value was 0.77 for computer programmers.

Summary

This chapter showed the frequency of skills in job postings and how those occupations related to those skills. Some of the highlights of this chapter are that systems skills were in high demand all across information technology. System skills include the ability to gather requirements, to design and to develop a product. It showed an apparent underrepresentation of web development skills, while showing a large emphasis on communication skills. The impact that this analysis can have on guiding decisions about the structure of education remains to be seen. The relationship between the job market and the skills will be more fully explored in chapter five.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Conclusions and Implications

This study sought to explore the viability of using a snapshot of job postings to analyze the state of employment in IT and how this snapshot could help create a decision support model for educational programs.

In Chapter I, the problem was stated and explained, and the approach was outlined. Chapter II reviewed how similar problems were investigated in the past and what gaps still exist in the research. Chapter III discussed in greater detail the investigation of the problem and the pros and cons of using a web crawler to mine text. In Chapter IV, the data was presented and analyzed. The data was specifically broken down into skills and into job occupations. This final chapter will take a more in-depth look at the data and address the problem head on, examining implications for the future.

Current Market Status

The job market is in constant flux and determining what will happen ten years out can be very difficult, and at times, reliant on luck. This study focused on using job postings as a comparison between various IT job categories and the skills in demand for the current job market in order to create better-informed decision-makers in academia. The purpose of this subsection is to analyze the data gathered and compare it to the BLS employment numbers.

Table 7 shows a breakdown of the number of job postings found during the month of November. It indicates that the most frequent occupation listed was information security analyst. Contrarily, the BLS employment predictions stated that the largest number of job openings would be for computer system analysts. This immediately indicates that the information security analyst is on the rise faster than predicted. This means there will be a skill gap in the information security analyst field unless it is addressed. This finding aligns with current news concerning hacking and system vulnerabilities.

The number of job postings indicates the number of job openings in a particular occupation. This can be an early warning sign on how the number of each job category will change over time. A larger number of openings means a larger desire for the skills associated with that job category.

Computer and information systems managers, the job category with the second highest number of job postings, indicated system skills as a primary skill set. The system skills skill set was most frequently the highest skill set for a number of job categories--not only computer and information systems managers, but also for network and computer systems administrators, computer programmers, and computer network architects. This indicates a desire for employees who can gather requirements for, design, and develop new software. All of these skills indicate growth of a business, which coincides with the current economic recovery.

Job postings can share a lot of information regarding the health of an industry. Computer programmers were expected to have a larger number of postings when compared to the BLS statistics. This could be for many reasons, but when taken in

conjunction with the system skills increase, it seems to indicate a shifting of job responsibilities. That business still wants to create new software, but the computer programmers are not coming from the United States. If they were coming from the United States, one would expect to see more job openings for computer programmers.

There are many practical implications resulting from an analysis of the current job market using job postings as the metric. An opportunity exists to understand how companies determine whom to hire and where they believe applicants are lacking skills. Educators can rectify this situation using information from the current market status. Overall, it is not the growth of the job category that this study is attempting to understand, but rather the growth of skills. The job categories can be fluid, but skills are more stable. Understanding how the skill requirements change over time leads to understanding how employability can change over time.

Future Market Status

The BLS comes out with employment projections every ten years. The latest projections were published in 2012. By creating a link between skills and job categories, it becomes possible to use these projections to predict the growth of skills over time. In order to do so, the skills must be normalized based on job category to reflect the percentage of total information technology jobs available in the United States. This is the method this study uses to create predictions on how skill attributes will change over time.

In table 22, the humanistic skill attributes are grouped into their skill sets and the normalized number of jobs is shown. The data again shows that the most frequently mentioned humanistic skill set is communication skills. Communication skills seem to be

a critical factor in many job categories and should be addressed explicitly by any prospective job candidate.

Table 22
Humanistic Skill Attributes

Skill Attributes	Normalized Frequency (N)	Percent (%)	Predicted Normalized Frequency (N)	Percent (%)	Predicted Growth (%)
Communication Skills					
Reading Comprehension	1,734,087	60.86	2,007,078	60.98	15.74
Written Communication	2,091,573	73.41	2,422,723	73.61	15.83
Oral Communication	1,928,950	67.70	2,234,459	67.89	15.84
Interpersonal Skills					
Work in teams	1,085,812	38.11	1,254,886	38.13	15.57
Negotiation skills	622,373	21.84	724,335	22.01	16.38
Leadership skills	1,526,309	53.57	1,765,391	53.64	15.66
Ability to learn and teach others	1,055,992	37.06	1,224,256	37.20	15.93
Basic Work Skills					
Proactive	948,434	33.29	1,096,977	33.33	15.66
Dependable	671,875	23.58	776,114	23.58	15.51
Adaptable	958,361	33.64	1,105,902	33.60	15.40
Ability to handle ambiguity	1,037,649	36.42	1,198,070	36.40	15.46
Ability to work under pressure	586,465	20.58	676,705	20.56	15.39
Open to new experiences	340,000	11.93	393,720	11.96	15.80
Creativity	227,893	8.00	263,160	8.00	15.48
Critical thinking	956,657	33.58	1,101,899	33.48	15.18

For every humanistic skill attribute, the predictive growth is between 15.15% and 16.38%. This gives humanistic skill growth a standard deviation of 0.29% and a mean of 15.66%. This small of a deviation supports the idea that communication skills are a staple skill for any job prospect. The business skill attributes below indicate that the most often desired business skill attribute is customer relations, which is different than the raw data,

which showed business ethics to be the largest (Table 23). The business skill attributes have a mean of 15.98% for the growth with a standard deviation of 0.67%. This demonstrates that business skills are relatively more varied than humanistic skills and therefore, focus may be more appropriate.

Table 23
Business Skill Attributes

Skill Attributes	Normalized Frequency (N)	Percent (%)	Predicted Normalized Frequency (N)	Percent (%)	Predicted Growth (%)
Business Communication					
Presentation skills	380,956	13.37	443,164	13.46	16.33
Business Interpersonal					
Customer relations	1,764,425	61.93	2,045,363	62.14	15.92
Business Work					
Analytic ability	1,051,036	36.89	1,227,335	37.29	16.77
Problem solving	778,281	27.32	903,229	27.44	16.05
Understand business environment	546,688	19.19	632,140	19.21	15.63
Knowledge of business functions	560,158	19.66	657,056	19.96	17.30
Ability to learn business functions	113,388	3.98	132,247	4.02	16.63
Understand organizational culture and politic	3,468	0.12	4,076	0.12	17.53
Business, Others					
Ethics and professionalism	1,732,502	60.81	2,005,414	60.93	15.75
Global awareness	506,421	17.77	586,577	17.82	15.83

Technical skills are the most prevalent of the skill attributes. In Table 24, the normalized growth for each technical skill attribute is listed below shown. The most frequent skill attribute that falls under technical skills is systems development; the least

frequent skill attribute is multiple factor authentication with only 0.12% of normalized jobs mentioning it in the job postings. Technical skills have the lowest mean at 15.53% and the largest standard deviation at 1.45%. This indicates that technical skills are less universal than business and humanistic skills. In other words, most jobs tend want similar humanistic and business skills, but unsurprisingly, the technical skills tend to be more specialized.

Table 24
Technical Skill Attributes

Skill Attributes	Normalized Frequency (N)	Percent (%)	Predicted Normalized Frequency (N)	Percent (%)	Predicted Growth (%)
Operating Systems					
Microsoft OS	1,294,438	45.43	1,492,084	45.33	15.27
Linux / Unix	454,499	15.95	519,107	15.77	14.22
MS Office					
Word	688,400	24.16	793,829	24.12	15.32
Excel	600,008	21.06	695,988	21.15	16.00
Business IT Solutions					
Business process analysis / design	148,787	5.22	174,388	5.30	17.21
Application development	1,279,633	44.91	1,485,522	45.13	16.09
Integrating business applications	324,331	11.38	377,543	11.47	16.41
Networking					
LAN/WAN	702,234	24.65	806,011	24.49	14.78
Setting up networks	523,513	18.37	602,872	18.32	15.16
Wireless networks	238,193	8.36	272,120	8.27	14.24
System Skills					
Gathering system requirements	292,305	10.26	348,450	10.59	19.21
System analysis	1,230,733	43.20	1,436,317	43.64	16.70
UML	109,178	3.83	124,201	3.77	13.76
System design	1,641,551	57.61	1,905,227	57.89	16.06
Systems development	1,718,539	60.32	1,990,681	60.48	15.84

System auditing	330,776	11.61	388,690	11.81	17.51
Programming					
COBOL	25,117	0.88	28,753	0.87	14.48
C#	190,311	6.68	216,563	6.58	13.79
JAVA	389,469	13.67	447,019	13.58	14.78
.NET	179,119	6.29	205,533	6.24	14.75
Visual Basic	152,931	5.37	175,785	5.34	14.94
HTML	181,561	6.37	208,160	6.32	14.65
XML	84,347	2.96	97,063	2.95	15.08
Database					
SQL	770,795	27.05	892,870	27.13	15.84
ORACLE	116,664	4.09	136,272	4.14	16.81
Data Mining	119,948	4.21	139,204	4.23	16.05
Database Management	780,459	27.39	902,597	27.42	15.65
Data warehousing	120,010	4.21	139,756	4.25	16.45
Sharepoint	144,108	5.06	168,150	5.11	16.68
Project Management					
Project Planning	607,707	21.33	708,248	21.52	16.54
Project Budgeting	1,117,769	39.23	1,296,734	39.40	16.01
Project Risk Management	764,950	26.85	890,693	27.06	16.44
Web Development					
Mobile Development / Responsive Design	58,941	2.07	67,573	2.05	14.65
Ruby on Rails	6,155	0.22	6,833	0.21	11.02
PHP	67,472	2.37	76,343	2.32	13.15
HTML5	154,939	5.44	176,908	5.37	14.18
Web 2.0	191,587	6.72	219,445	6.67	14.54
Security					
Multiple Factor Authentication	3,404	0.12	3,828	0.12	12.46
Penetration Testing	19,118	0.67	22,055	0.67	15.36
Application/Network Security	506,170	17.77	583,626	17.73	15.30
Access Management	309,470	10.86	363,647	11.05	17.51
Enterprise Resource Planning					
SAP	90,157	3.16	105,183	3.20	16.67
Oracle Business	328,114	11.52	381,508	11.59	16.27
Siebel	12,276	0.43	14,402	0.44	17.32

Service Computing					
Cloud Computing	311,275	10.92	358,146	10.88	15.06
SOA (Service Oriented Architecture)	109,596	3.85	126,934	3.86	15.82
Business Modeling	388,014	13.62	457,161	13.89	17.82

Recommendations for Education

The educational system is a large machine where every piece of it contributes to the development of its students. Schools have a self-interested goal of creating students that can find gainful employment after college. There are different ways to accomplish this goal. The coursework can address the most desired nontechnical skills that employers are looking for in job candidates. The majors students are guided towards can be ones where there might be a deficit in qualified candidates. The methodology of teaching can change to reflect more closely the methods used by employers. Students can be advised to craft their resumes to emphasize the skills that cater to potential employers.

First, the coursework can address the nontechnical skills. Knowing which skills are in demand can help focus assignments on developing particular skills. Assignments could be crafted to emphasize in-demand skills like ethical skills, which 60.81% of all jobs desire, or leadership skills, which 53.57% of jobs desire.

Second, a guidance counselor or advisor, knowing which skills and occupations tend to be on the rise, can make a more educated decision when recommending students to a particular path or major. For example, knowing that information security analysts are rising faster than expected means that there will be probably be more job openings than candidates. If a student seeks advice from the counselor, they could recommend a specialty in security, having reasonable confidence that they are increasing the student's

likelihood of being an appropriate candidate for the job market when the student graduates.

Third, the methodology of teaching can change to be reflective of the skills employers are looking to obtain. For example, system skills contain gathering requirements, designing, and developing a project. Designing a course based on building system skills can be a practical and useful experience for a potential job candidate. Another example could be to develop communication skills. A course could be designed to emphasize these skills in daily activities, like requiring students to communicate in a specific manner, or emailing them directions to assignments.

Lastly, a prospective employee can look at the skills required for a particular job and cater their resume to highlight the specific skills that the occupation tends to require. This could help a prospective employee stand out among their peers, which is an important first step in the employment process. For example, emphasizing your programming ability as a computer programmer may seem like the correct path, but emphasizing communication skills and database skills may also benefit the prospective employee.

The most effective strategy would be one that employed all these methods to mold a student into a promising job candidate. Whether these recommendations are taken, it is clear that a solid skill foundation is needed. Every skill set is represented in every occupation, which shows that employers want their job candidates to have a broad base of general education and great depth of knowledge in specific skills.

Recommendations for Future Research

No research is ever done in a vacuum. Techniques morph and thought processes change. In order to move this methodology from an exploratory phase to an implemented phase, a few items need to be adjusted.

Foremost, in order to increase the effectiveness of using this methodology in education, the job postings that are analyzed need to be entry-level jobs, or the jobs that graduates would obtain upon graduation. Limiting the data set to those jobs would help support the decision model efficacy and usefulness.

Second, as Table 7 shows, there was only recorded one job posting for computer science postsecondary teacher. This shows that not every occupation category uses CareerBuilder.com as a method to post their jobs. CareerBuilder.com focuses on the masses, and therefore some of the more specialized careers may not be posted on this website. Other sites need to be evaluated and incorporated into the web crawling in order to build a more comprehensive data set regarding job postings.

Third, the skill indexing could use improvement. This was an exploratory study where a lower Cronbach's alpha is acceptable to demonstrate that the methodology does not have a fundamental flaw. If this study were to move out of the exploratory phase, then the value for Cronbach's alpha would need to be increased. To do so, the indexing would need to be reviewed and shaped in a more consistent manner for information technology.

The final suggestion would be a survey analysis of employers, educators, current students and recent graduates to determine how best to demonstrate competency in the different skills. Since the ultimate goal would be to use the snapshot of job postings to

determine where job skill demand might be in four to five years, then knowing how a student could demonstrate competency in the skill in question would be useful knowledge in guiding pedagogy.

Conclusion

This exploratory study into determining the viability of using the BLS projections to predict skill growth demonstrated feasibility. A snapshot of the job market was taken and it showed internal consistency. The ability to take this snapshot of the job can edify the decision making process. The ability to use this snapshot to create predictions for the skill growth is something beyond that which had currently been done. Understanding the importance of the education process and how it can provide future candidates who are well suited to employment is a crucial piece of the curriculum design process. As a nation, when we focus on better preparation of our society for the future, we get stronger and more capable. We have a vested interest in pursuing the ideas which can help us better understand what will happen in the future because of actions of today. It was through that ideology that this study was conducted and reported.

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APPENDIX A

SAMPLE NORMALIZATION CALCULATION

For this sample normalization calculation, the job attribute of written communication was used. First, as seen in Table 25, the number of job postings that contained an index term for written communication was counted. Second, the total number of job postings for each job category was counted. Then, a simple percentage was calculated by dividing the total number of postings with the attribute by the total number of postings in the category (Table 25).

Table A1
Written Communication Attribute breakdown by Job Category

Job Category	Total Postings with Attribute (N)	Total Postings in Category (N)	Percent (%)
Computer and Information Research Scientist	443	568	77.99
Computer and Information Systems Managers	5275	6613	79.77
Computer Hardware Engineers	2975	4758	62.53
Computer Network Architect	1066	1455	73.26
Computer Network Support Specialist	1594	1955	81.53
Computer Operators	1816	2459	73.85
Computer Programmers	1401	2095	66.87
Computer Systems Analysts	3930	5220	75.29
Computer User Support Specialists	2555	3046	83.88
Database Administrators	3815	5433	70.22
Information Security Analysts	4832	6765	71.43
Network and Computer Systems Administrators	285	449	63.47

Table A2
Written Communication Attribute 2012 Calculation for Number of Jobs

Job Category	Percent (%)	2012 BLS Total Number of Jobs (N)	Predicted Number of Jobs (N)
Computer and Information Research Scientist	77.99	26,700	20,824
Computer and Information Systems Managers	79.77	332,700	265,385
Computer Hardware Engineers	62.53	83,300	52,084
Computer Network Architect	73.26	143,400	105,061
Computer Network Support Specialist	81.53	174,600	142,359
Computer Operators	73.85	74,600	55,093
Computer Programmers	66.87	343,700	229,844
Computer Systems Analysts	75.29	520,600	391,946
Computer User Support Specialists	83.88	547,700	459,414
Database Administrators	70.22	118,700	83,350
Information Security Analysts	71.43	75,100	53,641
Network and Computer Systems Administrators	63.47	366,400	232,570
Total			2,091,573

Table A3
Written Communication Attribute 2022 Calculation for Number of Jobs

Job Category	Percent (%)	2022 BLS Total Number of Jobs (N)	Predicted Number of Jobs (N)
Computer and Information Research Scientist	77.99	30,800	24,022
Computer and Information Systems Managers	79.77	383,600	305,987
Computer Hardware Engineers	62.53	89,400	55,899
Computer Network Architect	73.26	164,300	120,374
Computer Network Support Specialist	81.53	186,800	152,307
Computer Operators	73.85	62,000	45,788
Computer Programmers	66.87	372,100	248,836
Computer Systems Analysts	75.29	648,400	488,163
Computer User Support Specialists	83.88	658,500	552,353
Database Administrators	70.22	136,600	95,919
Information Security Analysts	71.43	102,500	73,212
Network and Computer Systems Administrators	63.47	409,400	259,864
Total			2,422,723

These simple percentages were then multiplied by the 2012 and 2022 BLS numbers of jobs for each category. These multiplications gave the predicted number of jobs for a given job category for a given skill attribute. These results were then added together to find the total number of jobs that require a given skill attribute. For 2012 calculations, see table 26. For 2022 calculations, see table 27. Lastly, to calculate the predicted growth, the percentage change between the total number of jobs for a given skill attribute was calculated using the difference between the 2022 total and the 2012 total as the numerator and the 2012 total as the denominator times 100.