Knowledge and Skill Requirements for Entry-Level IT Workers: A Longitudinal Study

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ABSTRACT

This paper provides an updated view of the importance of various skills and traits for entry-level IT workers, as perceived by the IT industry, based on a web-based survey administered to IT managers nationwide. The work presented in this paper is an extension of two previous studies based on a survey conducted in 2006. A new survey was conducted in 2010 that consisted of 48 skills and traits including personal and interpersonal skills, as well as technical skills. This study finds that the top 12 skills and traits for entry-level IT workers are personal and interpersonal skills with honesty and integrity ranked most highly. The top 5 technical skills have not changed considerably in the past five years. They are operating systems, security, hardware, networking, and database, which have been part of the IT core curriculum for many years. Based on the analysis of the survey, several recommendations for curricula for IT-related degree programs are provided.

Keywords: Job Skills, Computing Skills, Interpersonal Skills, Soft Skills

1. INTRODUCTION

In a recent Point/Counterpoint article in Communications of the Association of Computing Machinery, Andriole (Andriole and Roberts, 2008a) suggests the field of information technology (IT) is changing, and information systems (IS) and computer science (CS) programs have a responsibility to alter current curricula to address the changing fields. He claims that the number of programming jobs "… will decline, become more specialized, and distributed across the globe" (p. 29) and argues that CS programs should focus on more current, relevant skills such as service-oriented architecture (SOA), software as a service (SaaS), Web 2.0 and 3.0, and "focus less on alternative programming languages" (p. 29). In addition, Andriole outlines changes that need to be made in the IS curriculum. He also highlights the differences between what is in the current curriculum and what practitioners want. Roberts (Andriole and Roberts, 2008a) counters that the demand for employees with programming skills exceeds the supply and that the demand for IT workers in all computing disciplines is rising. He states that our problem is to increase the number of students in computer-related disciplines to respond to the increasing demand so that companies will have qualified alternatives for employment domestically as opposed to off-shoring IT-related jobs.

In a follow-up letter to the editor, Andriole (Andriole and Roberts, 2008b) points out that we still need a "greater emphasis on integration, interoperability, applications architecture, communications architecture, and data architecture" (p. 8). He agrees there will be a shortage of computing professionals, but not necessarily because we need more IS or CS students studying what is currently taught; perhaps it is because of "… the mismatch between what we teach and what employers need" (p.8). Roberts (Andriole and Roberts, 2008b) counters by saying the answer is to "… expand educational programs in the IT areas he (Andriole) championed but not at the expense of more traditional CS programs that produce too few graduates to meet industry demand" (p. 9).

What is clear from the exchange between Andriole and Roberts is that the IT industry has changed recently and that CS and IS programs in universities need to reflect these changes. Recent technological changes such as emphasis on integration and interoperability, emergence and increased reliance on virtualization, importance of security, increased importance of storage for the vast quantities of information we are producing, changes on the web (social media, blogging, etc.), need for integration, and the rise in increasingly complex computing architectures have potentially reshaped IT workforce requirements. Based on these characteristics and in keeping with Andriole's view that education should be "relevance driven" (Andriole and Roberts, 2008a), universities need to align curricula to produce the characteristics desired by industry.

IT is a fast-growing profession. According to Computerworld's annual forecast survey, nearly 29% of the 353 IT executives polled said they plan to increase IT staffing through next summer. That is up from 23% in the 2010 survey and another 20% above 2009 levels (Saia, 2011). The good news extends to recent college graduates who are currently seeing the largest growth in career opportunities. The U.S. Bureau of Labor Statistics reported in summer 2011 that the number of college graduates ages 20-24 years who found jobs increased by 11.8% between April and July in 2011 (Bureau, 2011). According to the U.S. Bureau of Labor Statistics, the Computer and IT occupations with a Bachelor's degree as the entry-level education are projected to increase 24% from 2010 to 2020 in average, much faster than the average for all occupations by adding 631,200 new jobs (Bureau, 2012). Money magazine and PayScale.com have been giving ratings to careers in the past five years (2006-2011). The 2011 list rated the 20 best jobs in America for fast growth (Money/Payscale.com, 2011). Out of the 20 careers, there are 8 jobs in the sector of information technology, with software developer ranked as number 1 ($82,400 median salary and 32% 10-year growth) and web developer ranked as number 18 ($60,900 median salary and 13% 10-year growth).

The IT profession is also well-known for its rapid development of new technologies. College students enrolled in IT-related degree programs should be prepared with knowledge and skills that are aligned with industry. Constant curriculum review and development is crucial. Program enrollments have been rising since 2008, reversing the national decline that started in 2000. For example, according to the Computing Research Association (CRA) 2010-2011 Taulbee survey, the number of new students majoring in computer science (CS) increased 9.6% in the 2011-2012 school year over the previous year, marking the fourth straight year of increased enrollments, and the number of bachelor's degrees in CS rose by 10.5% (Taulbee, 2011).

The primary purpose of this paper is to provide an updated view of the importance of various skills and traits for entry-level IT workers as perceived by the IT industry and discuss the results in light of curriculum design. To profile the characteristics of the modern IT worker, a nationwide cross-industry survey of IT managers was designed and conducted to determine the importance of various skills/traits for entry-level full-time IT employees.

2. LITERATURE REVIEW

This study is an extension of two previous studies (Aasheim, Li, and Williams, 2009a; Aasheim, Williams, and Butler, 2009b) conducted by some of the current authors, which were based on a nationwide survey conducted in 2006. Aasheim et al. (2009b) asked IT managers and workers to rate the importance of the 32 skills to entry-level IT workers based on a survey of 348 IT managers and 238 IT workers. Personal and interpersonal skills were consistently rated the most important on average, with honesty/integrity the highest-rated attribute on average. Awareness of IT technology trends, operating systems, and networking were the highest-rated technical skills/traits. The aim of the current study is to compare the results to the previous studies to investigate whether there are changes in importance of various skills and traits and to provide an updated look at knowledge and skill requirements for entry-level IT workers. The results will be used to provide updated curriculum recommendations.

There has been extensive research conducted in the IS/IT skills area. In order to focus on research related to the goals of this study, the literature review is divided into two categories. As one goal of this study is to provide an updated view of knowledge and skills industry deems important, the first section presents studies investigating the relative importance of various IS/IT skills. A second goal is to provide curriculum recommendations based on industry responses. To this end, the next section reviews studies that examine the perceived gap between industry and academia and that develop curricula or make curriculum-related recommendations based on IS/IT skills studies. Finally, a summary of the literature is presented.

2.1 Importance of IS/IT Skills

Many studies conducted in the past twenty years have investigated the importance of IS/IT knowledge and skills (Doke and Williams, 1999; Gallagher et al., 2010; Lee et al., 1995; Leitheiser, 1992). Gallagher et al. (2010) surveyed 104 senior IT managers in 94 non-IT companies in 2005 and found that foundational skills (programming, system testing, help desk, database, operating systems, and voice/data telecommunications) are not critical to retain in-house. These skills are important to get hired, but over time the importance of these skills diminishes. Another study by Lee et al. (1995) examined critical skills necessary for IS workers and made curriculum recommendations based on the

findings. Consistent with our 2006 study, many studies have found that personal/interpersonal skills are more important in new hires than core technical skills (Downey et al., 2008; Fang et al., 2005; Young and Lee, 1996).

A recent study by Lee and Mirchandani (2010) had students survey 70 IS managers. The IS managers rated their perception of the importance of IS/IT skills in the past (five years before today), present, and future (five years after today). The study found that the skills with fastest-growing importance are wireless communication and applications, mobile commerce applications and protocols, IS security, web applications, services & protocols, and data management. Based on these results, implications and recommendations for IS/IT educators, researchers, and practitioners are provided. However, in this study, only 21 companies from the Midwest U.S. were represented, and the IS 2002 model curriculum used to identify courses was relatively old.

Lee and Lee (2006) looked at 555 IT manager job ads from 2001 to 2003 and concluded that IT managers needed both technical (although less in the area of hardware) and behavioral skills. It was also noted in this study that management positions only mentioned certifications in 7.7% of the cases. Other studies that have also used job ads to collect data include the Prabhakar et al. (2005). They used Internet IT job ads to examine changes in demand of skills over a 3-year period (2002-2005). The top skills identified were web programming, Unix, C++, Java, SQL programming, and Oracle DB. Five percent of jobs ads required certification. Gallivan et al. (2004) examined classified ads for IT professionals from 1988-2003. They found that job ads focused on technical skills rather than the "soft skills" that organizations claim are important in new hires.

Using a survey for more than 150 IS graduates, Plice and Reinig (2007) determined that emphasizing technical topics in the IS program helped graduates in the short term, but maintaining the existing balance between business and technical skills taught in the program was beneficial to graduates in the long term as they moved to more managerial roles in their field. However, this study only looked at graduates from San Diego State University's IS program.

In another paper published the same year, Surakka (2007) used a Delphi technique to survey a small sample of Finnish IT professionals, academics, and students to evaluate the importance of various subjects and skills related to software development. This study compared the results to similar research done by Lethbridge (2000a, 2000b). Several of the findings of Lethbridge's studies still hold, such as less importance placed on continuous mathematics and basic science. In addition, new areas of emphasis were discovered, such as web-related skills. This study also analyzed the implication of the survey results for CS degree programs. Limitations of this study include older survey data and a small sample size: 11 software developers answered the survey in 2003-2004, 19 professors or lecturers in 2005, and 24 master's students in 2004. Downey et al. (2008) surveyed 153 IT professionals from 6 organizations in the mid-South about skills important for entry-level IT professionals and used the results to develop an IT model curriculum including core and specialization requirements. The authors found that personal traits are the most important, with technical skills such as database, object-oriented programming, or security being the next most important. The curriculum developed by the authors consisted of 9-10 core courses. However, this may not be the number of courses that are available for all programs. A limitation of this study is the small number of organizations examined.

Lastly, Abraham et al. (2006) conducted in-depth interviews with 104 senior IT managers. They found that the "business content" in IS curricula was highly likely to be retained in-house by the interviewees. In addition, they found that technical skills were cited as being more likely to be outsourced while being listed as the skills most desired in new hires. The sample in this research consisted of non-IT firms only and had a proportionally larger share of Fortune 500 companies than found in the overall population of organizations in the U.S.

2.2 The Perceived Gap between Industry and Academia

Many studies have examined the perception gaps between IS/IT industry and academicians with regards to knowledge and skill sets (Cappel, 2001/2002; Kim et al., 2006; Lee and Fang, 2008; Lee et al., 2002; Tang et al., 2000/2001; Trauth et al., 1993). Kim et al. (2006) examined the perceived IS/IT skills gap from the perspective of end-users, academia, and IS/IT employers by surveying 71 IS practitioners and comparing the results to the IS 2002 model curriculum and reports by employers. The study found that industry respondents indicated that project management, security, Enterprise Resource Planning(ERP), end-user computing, and the integration of soft skills were important and should be given more emphasis in the IS curriculum. A limitation with this study is that all the respondents were employees from one manufacturing firm in the Northeast.

Aasheim et al. (2009a) examined gaps between industry and academicians' perceptions based on the survey for 348 IT managers and 78 faculty members on the importance of 32 skills as they relate to entry-level IT workers. Overall, faculty and industry were in agreement about the ranking of the skills categories (interpersonal, personal, technical, organization, experience & grade point average (GPA)). There were some differences in specific skills (industry viewed hardware concepts, operating systems, packaged software, and work experience as more important than did faculty).

Lee and Han (2008) also studied skill requirements for entry-level IT professionals. The focus was on programmers/analysts in Fortune 500 companies and investigated the gap between the IS 2002 model curriculum and the requirements of industry. They found that application development, software, and social and business skills were highly valued and recommended that knowledge of technological trends, knowledge of business functions, and general problem-solving skills be taken into account by the designers of the future IS curriculum. Java was still the most popular programming language (cited specifically in 30.7% of 837 ads for entry-level programmers), followed by VB, then COBOL. The Lee and Han (2008) study adopted Lee's (2005) skill categorization, which was built on the coding framework proposed in the study by Todd et al.

(1995). Lee (2005) focused on the skills desired in systems analysts job ads posted on Fortune 500 corporate websites.

Finally, based on a field study of 9 IT executives, Havelka and Merhout (2009) developed a theoretical model of knowledge, skills, and abilities desired for IT professionals, named "theory of IT professional competence". The theory was composed of four broad categories: personal traits, professional skills, business knowledge, and technical knowledge. This study could help to better understand gaps between IT academic programs, employers' needs, and IT students' perceptions. However, the number of participants in this study was small. The theory needs to be further validated by larger scale studies.

2.3 Summary of Literature

There have been numerous research studies examining the importance of various IS/IT skills as well as studies examining the gap between industry perceptions and needs versus academic perceptions regarding the importance of these skills. Although many studies find that the "soft" personal and interpersonal skills are important (Downey et al., 2008; Fang et al., 2005; Young and Lee, 1996), job ads often focus on or only list technical requirements for applicants (Gallivan et al., 2004). Many studies have found that foundational skills are important for being hired; however this importance diminishes over time, and these skills are less likely to be retained by the organization (Gallagher et al., 2010; Plice and Reinig, 2007; Abraham et al., 2006). IS/IT managers need employees with technical as well as behavioral skills (Lee and Lee, 2006). Based on the combined results from these studies, one could infer that the soft skills are important for an employee's growth within an organization, whether it be to remain an employee or to be promoted to a more managerial role.

Skills growing in importance are related to wireless communication and applications, mobile commerce, security, web applications, and data management (Lee and Mirchandani, 2010). Having a particular type of certification as a requirement for employment is only mentioned in 7.7% of job ads for IS/IT managers (Lee and Lee, 2006) and only 5% of job ads for other positions (Prabhakar et al., 2005). Several studies highlight the existence of gaps between industry and academic perception regarding the importance of various skills and traits (Aasheim, Li, and Williams, 2009a; Lee and Han, 2008; Kim et al., 2006).

Limitations of many of these studies relate to the small sample size or narrow scope of the sample size which leads to questions about the generalizability of the findings. Another limitation of some of the studies is that they may currently be out-of-date due to the initial timeframe during which the study was conducted.

3. METHODOLOGY

The primary purpose of this study is to provide an updated view of the importance of various skills and traits for entry-level IT workers as perceived by IT managers. To this end, a survey was administered to IT managers and IT workers nationwide. In addition, a longitudinal comparison to a similar study conducted in 2006 (Aasheim, Li, and Williams, 2009a) is done to determine if there have been changes in skills considered important in the IT field. This study will overcome limitations of previous studies by reaching a larger and broader sample of industry respondents.

The survey instrument contains questions related to skills and traits of entry-level employees as well as demographic questions about the respondent and the respondent's organization. The questions related to skills and traits were created by combining questions from Aasheim et al. (2009b) with skills, knowledge areas, and traits listed in the ACM/IEEE – IT 2008 curriculum guidelines and in the program outcomes in the ABET accreditation standard for IT programs. Certification and research experience were added as traits. The rationale for including certification is that the ACM/IEEE IT 2008 model curriculum does not advocate certification as part of academic credit. The authors wanted to see if industry opinion differed. Research experience was added because undergraduate students sometimes get the opportunity to conduct research with faculty. The authors wanted to see whether industry considers research experience important. A copy of the survey instrument can be found in the Appendix.

The survey consisted of 48 skills/traits that participants were asked to rate in terms of importance on a scale of 1 (not important) to 5 (very important). The survey was web-based and administered via email by a reputable online survey company to IT managers listed in a database maintained by the survey company. There were 315 respondents with 310 responses complete enough to use for analysis. Rationale for using a survey company is to gain access to the widest spectrum of IT managers as possible for the greatest generalizability of the study results. Of the 310 that were complete enough for analysis, 282 respondents were currently working in the IT industry. These were the responses used for analysis.

4. DATA ANALYSIS

4.1 Profile of Respondents and Their Organizations

The majority of the 282 respondents in the IT field (68.4%) indicated they were currently in an IT leadership position when asked for their current job title. Table 1(a) provides the percentage of respondents by their current job role. The location of respondents' organization includes all but 7 states, as well as 3 international organizations. Table 1(b) shows the percentage of respondents by state for the top most-represented states. The size of the respondents' organizations, as measured by the number of employees, varied from under 100 (17.4%) to over 10,000 (24.8%). Table 1(c) provides the breakdown of the size of the respondents' organizations. The respondents were from a variety of organizations in different industries with most respondents coming from an organization in the IT industry. Table 1(d) provides a breakdown of respondents by type of organization.

Respondents were asked about areas in which they were hiring entry-level IT workers in the next year. Table 2 shows the areas in which respondents were hiring entry-level IT in the next year and knew the areas in which they were hiring (n=194). The respondents could select more than one area, so percentages add up to more than 100%.

4.2 Importance of Various Skills/Traits to Entry-Level Full-Time IT Employees

In order to assess what skills/traits are important for IT-related degree programs, respondents were asked to rate the 48 skill/traits desired in entry-level IT employees listed in Table 3 in importance on a Likert scale with 5 being "very important" and 1 being "not important". The mean rating, rank, and adjusted rank are provided in the second column in Table 3. The adjusted ranking is based on ranking of the IT-related skills specifically (note that the non-technical skills have gray backgrounds).

Position	Percent
Manager	30.85%
Vice President & Assistant Vice President	4.26%
Chief Information Officer	4.26%
Chief Executive Officer	2.48%
Director	14.18%
Project Manager or Project Lead	6.03%
Administrator	3.55%
Coordinator	0.71%
Owner	2.13%
IT Worker	31.55%

(a) Respondents by Position

State	Frequency	Percent
California	31	11.0%
New York	29	10.3%
Texas	19	6.7%
Illinois	18	6.4%
Virginia	16	5.7%
Pennsylvania	14	5.0%
North Carolina	11	3.9%
Florida	10	3.5%
Ohio	10	3.5%

(b) Respondents by State

Number of Employees	Percent
<100	17.38%
100-499	17.73%
500-999	13.12%
1000-9999	24.82%
>10000	24.82%
No response	2.13%

(c) Respondents by Size of Organization

Primary Business	Percent
IT	31.2%
Financial	11.0%
Government /Military	9.6%
Manufacturing	8.9%
Health care	7.8%
Education	7.1%
Other	24.5%

(d) Respondents by Organization Type

Table 1: Demographics of Respondents

The top 12 most important skills/traits can be categorized as personal or interpersonal. After personal and interpersonal skills, the next most important skill is "relevant" work experience (ranked 13) which is much more highly-ranked than "any" work experience (ranked 25) or internship/co-op experience (ranked 43).

The top 10 technical skills are operating systems, security, hardware, networking, database, packaged software, systems administration and maintenance, integration of IT solutions, business intelligence, and web systems development. All technical skills, marked with an adjusted rank, are considered at least somewhat important (3.3+ on a 5 point Likert scale, between neutral and important). The technical skills with the lowest average ratings are ERP (3.30) and virtualization (3.46).

IT Help Desk	45.88%
Networking	34.54%
Programming/Software Engineering	33.51%
Database	29.90%
Security	29.38%
Systems Analysis and Design	25.26%
Business Intelligence	23.20%
Storage	22.68%
Web Design & Development	22.16%
Virtualization	21.65%
Enterprise Resource Planning Systems	20.10%
Disaster Recovery	17.53%

Table 2: Areas for Hiring Entry-Level IT Workers (in the Next Year)

Awareness of IT technology trends ranked higher than any of the skills/knowledge areas typically taught in an IT program. In addition, awareness of the impact of IT on individuals, the community, or globally was ranked higher than all but two of the technical skills.

4.3 Longitudinal Comparison to 2006 Study

In order to determine if any differences exist in skills since the 2006 study, the results of this 2010 survey are compared with the previous survey in 2006. In (Aasheim, Williams, and Butler, 2009b), 348 IT managers and 238 IT workers were surveyed, and they were asked to rate 32 skills in importance for entry-level IT workers on the same 5 point Likert scale used in this study. The current 2010 study included several new skills (e.g., virtualization, storage, and configuration management) that were not included in the 2006 study as well as some additional personal traits (e.g., attitude, willingness to learn new skills, and professionalism). As the comparison can only be made on skills and traits that were included in both studies, only the 32 skills/traits from the 2006 study are compared in the third column in Table 3 (note that skills that did not exist in the 2006 study have no statistics and have gray backgrounds). In the 2010 study, internship and co-op experience were combined as one item. To reconcile this with the 2006 study, ratings for internship from the 2006 study are used for comparison to the 2010 study. As a note, neither co-op nor internship experience ranked very highly in either study, so this should not be an issue.

The third column in Table 3 provides a comparison of the two studies by mean of each item and a comparison of the overall ranking of each item. The p-values for the mean comparison are based on a one-tailed z-test, as the data was collected from independent large samples.

	Current 2010 Study			Longitudinal Comparison				
					2006		Comparison	
Skill/Trait/Knowledge Area	**Mean**	**Rank**	**Adjusted Rank**	**2010 Rank**	**Mean**	**Rank**	**Diff in rank**	**p-value**
Honesty/integrity	4.55	1		1	4.62	1	0	*0.09
Attitude	4.49	2						
Willingness to learn new skills	4.44	3						
Communication skills (oral and written)	4.42	4		2	4.52	2	0	**0.03
Analytical skills	4.40	5		3	4.52	2	1	**0.01
Professionalism	4.38	6						
Ability to work in teams	4.37	7		4	4.51	4	0	**0.01
Flexibility/adaptability	4.32	8		5	4.38	5	0	0.15
Motivation	4.31	9		6	4.36	6	0	0.2
Interpersonal skills	4.23	10		7	4.36	6	1	**0.01
Creative thinking	4.12	11		8	4.19	8	0	0.14
Organizational skills	4.10	12		9	4.12	9	0	0.37
Relevant work experience	4.05	13		10	4.05	10	0	0.5
Awareness of IT technology trends	4.02	14		11	4.05	10	1	0.32
Operating systems	4.00	15	1	12	4.01	12	0	0.44
Security	3.98	16	2	13	3.91	14	-1	0.16
Awareness of impact of IT	3.96	17						
Hardware concepts	3.95	18	3	14	3.91	14	0	0.28
Networking	3.93	19	4	15	3.92	13	2	0.44
Database	3.88	20	5	16	3.86	16	0	0.39
Packaged software	3.84	21	6	17	3.84	17	0	0.5
System administration and maintenance	3.81	22	7					
Integration of IT solutions	3.80	23	8					
Knowledge of primary business functions	3.74	24		18	3.68	21	-3	0.2
Any work experience	3.71	25		19	3.81	18	1	*0.07
Business intelligence	3.71	26	9					
Web systems development	3.70	27	10	20	3.79	19	1	0.13
Knowledge of your company's specific industry	3.70	28		20	3.55	26	-6	**0.02
Leadership skills	3.69	29		22	3.58	25	-3	**0.06
Project management	3.68	30	11	23	3.61	23	0	0.18
Knowledge of your company	3.67	31		24	3.61	23	1	0.21
Relevant certification	3.66	32						
System integration and architecture	3.64	33	12					
Configuration management	3.62	34	13					
Human computer interaction	3.61	35	14					
Systems development life cycle methodologies	3.60	36	15	25	3.73	20	5	*0.05
IT disaster recovery	3.60	37	16					
Storage	3.59	38	17					
Information assurance	3.59	39	18					
Programming	3.59	40	19	26	3.68	21	5	0.15
High IT GPA	3.46	41		27	3.47	27	0	0.45
Virtualization	3.46	42	20					
Internship/co-op experience	3.45	43		28	3.39	28	0	0.22
Relevant academic research experience	3.40	44						
High overall college GPA	3.31	45		29	3.27	29	0	0.3
ERP systems	3.30	46	21					
Entrepreneurial skills	3.27	47		30	3.18	30	0	0.14
Extra-curricular activities	3.03	48		31	2.96	31	0	0.19

** Significant at 0.05, * significant at 0.10

Gray background = non-technical skills that do not have an adjusted rank or skills not included in both studies which cannot be compared

Table 3: Importance of Skills/Traits and Comparison to 2006 Study

The top 12 skills/traits are ranked the same as they were in the 2006 study with skills/traits in the personal and interpersonal categories occupying the top nine positions. Some of these skills are less important than in the 2006 study according to a statistical comparison of means using a t-test - communication skills, analytical skills, the ability to work in teams and interpersonal skills as well as honesty/integrity to some extent. The next two most-important traits are relevant work experience and awareness of IT technology trends, with neither changing in comparison to the previous study.

The top 6 technical skills in both studies are operating systems, security, hardware, networking, database, and packaged software. The only slight change is that networking fell below security and hardware in ranking in 2010 as compared with 2006. According to a z-test comparing the means of both studies, there is no significant difference found in importance of any of these skills.

Knowledge of the company's industry and leadership skills have both increased in mean importance and overall ranking in the 2010 study. Systems development life cycle (SDLC) methodologies and programming have both decreased in the overall ranking of skills. In addition, the SDLC has become less important on average when compared to the 2006 study while programming is statistically unchanged in average importance since 2006.

After the top tier of technical skills, there are three skills that are in the top 10 technology skills in the 2010 study that were not previously included in the 2006 study; they are system administration and maintenance, integration of IT solutions, and business intelligence. The personal skills added to the 2010 study - attitude, willingness to learn, and professionalism are ranked highly as well (2, 3, and 6 respectively).

5. KEY FINDINGS AND IMPLICATIONS

Several key findings based on this study are summarized in the next section. The findings have implications for institutions, faculty, and curricula. The implications for institutions and for faculty are provided in two sections following the key findings.

5.1 Key Findings

Employers want to hire entry-level employees with technical skills as well as non-technical skills. This is consistent with previous skills studies. The nature of the core technical skills for IT-related programs may be changing. This is not surprising given how much IT has changed in the past five years. However, the top five technical skills or knowledge areas desired in entry-level IT workers identified were operating systems, security, hardware, networking, and database. These are the same as the top five technical skills identified in the 2006 study. The findings also correspond with a recent independent study conducted by Computerworld.com (Saia, 2011). Historically, these skills have been the core of the IT field and remain so today.

Programming, systems development life cycle (SDLC) methodologies and human computer interaction are not in the top ten skills. In the past, programming and the SDLC (one or both) have been mainstays of many IT-related degree programs.

The identification of operating systems as the most important skill in both studies is consistent with the high percentage of respondents' organizations hiring entry-level IT workers as help desk personnel (see Table 2) who commonly support user operating systems. The breadth of systems and platforms has significantly increased with the advent of cloud computing. Further, as operating system image configuration and provisioning has become more complex, more entry-level IT professionals are needed to provide support. All these factors may be responsible for driving continued demand for help desk personnel that have operating system skills

There is a disconnect between Tables 2 and 3 regarding the importance of programming; Table 2 shows that 33.51% of respondents are hiring programmers and software engineers in the next year, and Table 3 indicates a relative lack of importance of programming/software engineering with programming skills only ranked as 41 out of 48. This disconnect is because those who are hiring programmers ranked programming higher than those who are not (ranked as 15 in importance as opposed to 43 when only considering the 33.51% of respondents hiring in these positions). Further explanation concerns the current state of the economy. Organizations tend to reduce spending and investment during periods of economic turbulence. The need for programmers and software engineers may therefore be reduced if firms are not investing in the development or expansion of systems.

Another interesting finding is that hiring managers desired graduates with strong interpersonal skills more than they sought candidates with relevant prior experience. Perhaps this indicates a willingness among employers to train strong candidates. It is also surprising that internship/co-op experience was rated far lower than relevant work experience.

The most highly-ranked skill/trait overall is honesty/integrity. This is not surprising given that the IT staff is entrusted with the organization's data, information, and systems that access the data and information and are responsible for securing that data. In addition, IT professionals ensure that the rest of the employees of an organization are behaving ethically with regards to IT (not surfing unauthorized Internet sites, not shopping online, not downloading non-work related applications, not using email for personal or unauthorized use, etc.).

5.2 Implications for Faculty

Faculty need to teach the technical skills, but they also need to focus on the important softer skills as well and ensure that students stay abreast of technology trends. Honesty/integrity was the highest ranked item overall on the survey. Although one cannot teach a student to be honest or to have high integrity, the teaching of ethics and ethical decision-making can increase awareness of ethical dilemmas, especially as they relate to IT, as well as highlight the importance of considering alternatives and their consequences when making decisions and the consequences of each alternative (Harris et al., 2011; Whitbeck, 1995).

The next most highly-ranked traits were attitude and willingness to learn. Teaching a student to have a positive attitude or influencing their willingness to learn is difficult. However, as educators we can share these results and

highlight the importance of attitude. We can also stress how much IT changes, especially in earlier classes in the curriculum, to educate students about the fact that they will be constantly learning in the IT field, arguably more so than in many other fields. Teaching students about professionalism, how to communicate, and how to work in teams are important in an IT program as well, as reflected by the survey results.

IT-related degree programs also need to include coverage of trends in technology, what reputable sources to use to keep abreast of these trends, and the impact of changes in technology on the organization and individuals in the organization. These topics were ranked as more important or at least as important as the top technical skills listed.

There is a need for a broader range of technical skills for the IT worker based on the data shown in Table 3. This is consistent with the points made by Andriole (Andriole and Roberts, 2008a; Andriole and Roberts, 2008b). Andriole (Andriole and Roberts, 2008a) points out the need for coverage in IT-related degree programs of some of the newer technologies and concepts that have become pervasive in industry. However, Andriole and Roberts (Andriole and Roberts, 2008a; Andriole and Roberts, 2008b) are in disagreement about how to go about incorporating these into curricula. Suggestions for doing so are discussed in the section on implications for institutions.

5.3 Implications for Institutions

Andriole (Andriole and Roberts, 2008a) suggests that CS and IS degree programs need to add areas of coverage. However, outside of programming, there are no suggestions about what to de-emphasize in the place of adding these areas to curricula. What do we drop in the already full IS curriculum besides programming to cover "…business analytics, supply-chain optimization, technology performance management, business process modeling, full-view business intelligence, sourcing, and large amounts of technology management skills…"? How does one fit SOA, Web 2.0 and 3.0, SaaS, thin client architecture, digital security, open source software, interoperable architectures into a CS curriculum that still needs to produce proficient programmers? Similar to the technologies discussed by Andriole and Roberts (2008a), this study found that web technologies, system administration, integration of solutions, and business intelligence are highly valued skills.

Based on our results, programming is still important as 33.5% of respondents are hiring programmers (Table 2), and respondents rated its importance on average as a 3.59 (Table 3). As applications are increasingly more complex, CS and software engineering (SE) programs will need to produce graduates equipped with programming skills to develop and maintain these more-complex applications. Therefore, the demand for graduates for CS and SE programs is still there, and these programs are more relevant than ever.

Additionally, there is a need for degree programs other than CS and IS to cover the broad range of topics as there is no room to fit all of these new topics into already full IS and CS curricula. Roberts (Andriole and Roberts, 2008a) advocates the need for all five computing-related degree programs (CE, CS, IS, IT, SE) identified by the Joint ACM/IEEE Task Force on Computing Curricula. Given the broad range of skills important to industry, there is a need for all five of these programs and perhaps additional, more specialized degrees. Each major within an academic institution must draw conclusions about which of the skills to specialize in or emphasize. In addition, each degree program could have specializations or areas of concentration where that major provides coverage of topics in more depth in a particular area. As Roberts (Andriole and Roberts, 2008a) indicated, we need more students in the field to meet industry demand, not fewer. This is consistent with the 69% of respondents in our study indicating that they were hiring currently (194 out of 282) with many hiring for multiple positions (see Table 2).

Andriole (Andriole and Roberts, 2008a) states that programs need to coordinate their efforts and cooperate to produce graduates with the skills desired in industry. IT as a discipline has become as complex, diverse, and as heavily-relied upon as any other academic discipline. The field is large and has many important skills (almost every skill in Table 3 is rated at 3.5 or higher, including programming), and an individual major or two cannot cover them all. To facilitate and ensure the cooperation and coordination suggested by Andriole (Andriole and Roberts, 2008a), like many other academic disciplines, IT-related programs could be located in the same organizational structure within an institution, perhaps with the exception of Computer Engineering. Another possibility is that units with IT-related degree programs could be encouraged to offer joint degrees.

6. CONCLUSION AND FUTURE RESEARCH

A survey with 282 respondents of which 72% were in a leadership role was administered to determine the importance of various IT skills and knowledge areas as well as personal and interpersonal traits. After analyzing the average responses, several ideas for curricula recommendations for IT-related programs were suggested. These included the importance of teaching ethics, professionalism, communication skills, and how to work in teams. In addition, educators in these programs should stress the need for continued learning throughout an IT worker's career and the importance of attitude and motivation in the IT field. Of course, one could argue that these personal and interpersonal skills are important in all fields and should be included as part of the core curriculum in all universities. Future research could investigate whether the non-technical softer skills are valued more in technical fields as compared to other fields.

The core skills and knowledge areas in an IT program have not changed considerably in the past 5 years. They are operating systems, security, hardware, networking, and database according to the responses in this survey. In addition, IT programs should include coverage of technology trends and their impact. One noticeable change is the relatively lower ranking of programming, typically considered part of the IT core, in relation to other technical skills listed on the survey. However, programming did not change in average importance, statistically.

This study overcomes some of the limitations of previous studies by sampling a large number of respondents from across the nation in a variety of industries of different sizes. The respondents were primarily in leadership roles.

Areas of future research include a comparison of the results to current model curricula and accreditation standards for IT-related degree programs. As mentioned previously, another area of research is to compare the skill ratings for employers hiring programmers and software engineers to those that are not. This will highlight some of the key differences between important skills/traits for students in degree programs that focus on programming and software engineering, like computer science, and those for students in other IT-related degree programs, like information technology and information systems.

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APPENDIX – SURVEY INSTRUMENT

1. What is your job title
2. In what state do you work?
3. What type of industry best describes the primary business of your organization?
4. What state is the primary location of your organization/company?
5. What best describes the size of your organization measured by the number of employees?
6. Approximately how many IT employees are there in your department, division or area?
7. In which area(s) does your organization expect to hire IT full-time entry-level employees in the next year? (Check all that apply)
   Database
   Disaster Recovery
   Enterprise Resource Planning Systems
   IT Help Desk
   Networking
   Programming/Software Engineering
   Security
   Storage
   Systems Analysis and Design
   Virtualization
   Web Design & Development
   Business Intelligence
   I do not know
8. Does your company generally buy or build its software applications not including personal productivity software (e.g. Microsoft Office)? Check all that apply.
   Build in-house
   Buy third-party custom-built software
   Buy off-the-shelf
   Customize off-the-shelf
   I do not know
9. Please rate the importance of the following skills and traits on a scale of 1 to 5 (1 being "not important" and 5 being "very important") as they relate to full-time entry-level IT employees.
   Communication skills (oral and written)
   Ability to work in teams
   Interpersonal skills
   Creative thinking
   Analytical skills
   Honesty/integrity
   Flexibility/adaptability
   Leadership skills
   Organizational skills
   Entrepreneurial skills
   Motivation
   Professionalism
   Attitude
   Willingness to learn new skills
   Knowledge of your company
   Knowledge of primary business functions (e.g., finance, marketing)
   Knowledge of your company's specific industry (retail, health care, transportation)
   Awareness of IT technology trends
   Awareness of impact of IT (on individuals, community or globally)
   High overall college GPA
   High IT GPA
   Extra-curricular activities
   Programming (Java, COBOL, etc.)
   Web systems development (XHTML, XML, Javascript, JSP, ASP, etc.)
   Database
   Networking
   Security
   Software engineering
   Systems development life cycle methodologies

Hardware concepts (PC, server, router, network)
Packaged software (e.g. word processing, spreadsheets, etc.)
Operating systems
Project management
ERP systems
IT disaster recovery
Virtualization
Storage
Business intelligence (e.g. reporting, analytics, data mining)
Human computer interaction (e.g. interface design, user testing, etc.)
System integration and architecture
System administration and maintenance
Information assurance
Integration of IT solutions
Configuration management
Relevant work experience
Any work experience
Internship/co-op experience
Relevant academic research experience
Relevant certification

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