

Synthesizing IT Job Skills Identified in Academic Studies, Practitioner Publications and Job Ads

Haiyan Huang
Purdue University
335A Anderson Building
Hammond, IN 46323 USA
1.219.989.8159

haiyan.huang@calumet.purdue.edu

Lynette Kvasny
Pennsylvania State University
329C IST Building
University Park, PA 16802 USA
1.814.865.6458

lkvasny@ist.psu.edu

KD Joshi
Washington State University
440B Todd Building
Pullman, WA 99164 USA
1.509.335.5722

joshi@wsu.edu

Eileen Trauth
Pennsylvania State University
332Q IST Building
University Park, PA 16802 US
1.814.865.0077

etrauth@ist.psu.edu

Jan Mahar
Pennsylvania State University
321F IST Building
University Park, PA 16802 US
1.814.863.9088

jmahar@ist.psu.edu

ABSTRACT

This research examines IT job skills across three genres of texts: scholarly articles, practitioner literature, and online job ads. The job skills are organized in three broad categories: technical, humanistic and business skills. Findings suggest that the online advertisements list a strong mix of skills in these three categories, while practitioner literature tends to focus heavily on technical skills. The most recent practitioner literature, however, notes that CIOs are increasingly demanding business acumen as well as technical skills. Project management, financial analysis, and communication skills are the most frequently cited business skills. The scholarly literature tends to lag behind in terms of specific technical skills, but reports the richest set of IT job skills across the three categories.

Categories and Subject Descriptors

K. Computing Milieu, K.7 The Computing Profession, K.7.1 Occupations, K.6 Management of Computing and Information Systems, K.6.1 Project and People Management

General Terms

Management

Keywords

job skills, content analysis, IT professionals, IT careers

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

SIGMIS-CPR '09, May 28–30, 2009, Limerick, Ireland.

Copyright 2009 ACM 978-1-60558-427-0/09/05...\$5.00.

1. INTRODUCTION

Since the 1990s, several scholarly studies have examined the job skills required for IT professionals. These studies have used a variety of methods including content analysis of job advertisements [1][2][3][4][5][6], interviews with hiring IT managers, traditional surveys [7], surveys and focus groups [8], and Delphi studies [9]. These studies consistently report shifts in the relative importance of technical job skills. For instance, scholars report evidence of the growth in computer networking skills, object-oriented programming, and ERP during the 1990s. In this same time period, scholars reported the decline of mainframe systems, hierarchical and network DBMS, and CASE tools [7][3][9]. Perhaps surprisingly, all of these studies found that demand for COBOL remained relatively stable [1][2][4]. Another consistent finding is that, across diverse IT job types such as programmers, systems analysts and IT managers, employers are demanding technical skills as well as more business knowledge and stronger interpersonal skills for working with customers and users [10]. Thus, there is growth in the total number of skills expected of IT workers.

In addition to this body of scholarly literature, trade magazines typically report on the changing nature of IT job skills, and publish “top 10” lists of the hottest IT job skills. Sometimes these rankings are based on surveys with hiring IT managers. More often, however, the lists are based on the authors’ experience and knowledge of the IT field. Changes in job skills for IT professionals can also be inferred from IT job advertisements.

To make sense of this complex mix of skill sets, we examine the structure of IT job skills across three genres of documents – scholarly papers, job advertisements and practitioner articles. This research is guided by four research questions:

1. What technical, humanistic, and business skills are identified in IS scholarly articles?

2. What technical, humanistic, and business skills are most commonly identified in IT practitioner literature?
3. What technical, humanistic, and business skills are most commonly identified in online IT job advertisements?
4. What IT jobs skills are common across these three data sources?

In the next section, we describe the methodology employed in our study. Next we present the findings of this analysis and conclude with implications for research.

2. METHODOLOGY

Scholarly articles were compiled using the ProQuest database to search for full text articles using “*Information Technology AND skills*”. When reviewing the literature, we focused on 3 broad skill categories – humanistic, business, and technical. Within the technical domain, some papers listed a broad set of specific skills or a rich set of technical skills required for specific IT jobs such as programmer or systems analyst. Other papers addressed technical skills more generally in terms of about curriculum development in specific technical college majors or predictions about new IT jobs and skills.

To locate practitioner articles, we used the ProQuest database to search for full text articles using the keywords “*Information Technology AND skills*”. The search results were sorted in reverse chronological order and only articles from 2003 – 2008 were selected for subsequent analysis. Working within these constraints, 116 articles from practitioner outlets such as Network World, Computerworld, Info World, and eWeek are analyzed.

Job advertisements provide information about employers’ expectations of potential employees and other information about evolving skill sets required in the technology workforce. We selected 241 online job ads listed on Monster.com from April 2008 - June 2008. For our analysis, we documented the prospective job company, the job description, and the complete job requirements broken down into Soft and Technical skills.

The three datasets were analyzed using a two stage, grounded approach in which the IT job skills emerged from the data. In the first stage, three coding schemes were developed based on the articles and job advertisements. The codes fell into three standard categories: humanistic skills, business skills, and technical skills. In the second stage, we synthesized and summarized the data across the three data sources to develop a comprehensive set of codes.

3. FINDINGS

3.1 Job Skills Identified in IS scholarly Literature

The IS scholarly literature suggests 19 technical job skills. These skills are ranked in Table 1 by counting the number of times each technical skill is included in prior studies.

Table 1: Technical Job Skills

Skills	
1.	Business Analysis
2.	Network
3.	Integrate Business Application
4.	Database
5.	Telecommunications
6.	Operating Systems
7.	System analysis
a.	Systems Life Cycle
b.	Argue for new or existing systems
c.	Analyze existing or new technology for overall system and corporate need
d.	Anticipate implementation problems
e.	Gathering system requirements
8.	Programming
9.	Ability to learn new technologies
10.	Ability to focus on technologies a means, not an end
11.	Web development
12.	Ability to understand technological trends
13.	Application development
14.	Computer problem solving skills
15.	Word processing
16.	Ability to assimilate new technology
17.	Systems development
18.	Data and communication technology
19.	Computer security

In the second category, general business skills such as leadership and project management, and particular business area knowledge such as finance and company-specific knowledge dominated the findings are listed. These business skills are ranked in Table 2 by counting the number of times each skill is included in prior studies.

Table 2: Business Skills

Skills	
1.	Knowledge and the ability to learn business functions
2.	Develop solutions to business problems
3.	Understanding of business environment
4.	Problem solving
5.	Project management
6.	Ethics
7.	Business skills - general
8.	Time management
9.	Decision making and analytical ability
10.	Global awareness
11.	Presentations skills
12.	Being able to handle politics
13.	Business area knowledge
14.	Customer service
15.	Project management

Humanistic job skills were the least frequently cited skill type in the IS academic literature (Table 3). Within this category, teamwork and leadership were found most frequently. It is worth noting that these skills represent enduring concepts that serve as cornerstones for overall job effectiveness and success.

Table 3: Humanistic Job Skills

Skills
1. Teamwork
2. Leadership
3. Writing/presentation skills
4. Ability to teach others
5. Customer relations
6. Proactive
7. Sensitive to other cultures
8. Communication
9. Ability to handle ambiguity
10. Openness to new experiences

3.2 Job Skills Identified in Practitioner Publications

In this study, 116 Practitioner journals found in ProQuest and 156 unique job skills were identified. These skills include 140 technical skills in areas such as programming, networking, data management and Web development; 6 humanistic skills (social skills, world knowledge, risk taking, ability to get point across, inquisitive, initiative), and 9 business (marketing, finance, business process mapping tools, organizational skills, Control Objectives for Information and related Technology (COBIT), facility skills, eco-friendly computing, accounting, company knowledge, teamwork).

A CompTIA skills survey released in February listed security as the No. 1 skill among three quarters of the 3,578 IT hiring managers polled [11]. Our study also found that security is the top IT job skill. Security was mentioned in a little over half (62) of the practitioner articles, while a little less than half of the articles mentioned the importance of project management. The most popular programming languages were java (23) and C++ (12). As businesses update their networks and there is a need for people who have IT architecture skills and networking skills. The Microsoft .Net framework (25), Networking (17), and wireless networking (15) were very popular skills to possess. Another area of note is that companies are moving from Windows to Linux or Unix, and moving to open source software. There is a large cost of setting up and maintaining these systems so businesses are trying to hire people with these skills [12].

There is a perception among practitioners that there will eventually be very few programmers who have mainframe computing skills and knowledge of legacy systems. This concern results from a perceived shortage of students enrolling in the IT and computer science field coupled with the large number of baby boomers retiring in the next couple of years. Practitioner research suggests that these legacy technologies will still be around after the baby boomers are gone, but there seems to be very little interest in current students with programs in these areas [13]. Industry demand and university training are better aligned in the areas of established technologies like Java and other object oriented programming languages. Web 2.0 and AJAX are also gaining in importance as companies are trying to figure out how to leverage Web 2.0 applications in corporate settings.

Another trend is the call for IT professionals to develop business acumen and business intelligence skills. As technology becomes more commonplace in the corporate sector, IT employees will have to develop more soft skills like project management, communication skills and interpersonal skills [14]. Client facing

software and a need to have good communication channels with the clients or other parts of the company are also mentioned as important skills. While several articles mention the convergence of business and technology and the need for IT professionals to develop soft skills, this concern is not well reflected across the articles. For instance, of the top 30 job skills, 90% (27) were technical. Only 1 humanistic (ability to work in teams) and 2 business (finance and organizational knowledge) made the ranking.

The articles also discuss outsourcing and the effects that it will have on IT job skills. Some analyst argue, for instance, that with the increase in outsourcing and offshoring, there will be a great demand for people who have the skills to work in virtual teams and be able to manage international teams. These results are summarized in Table 4.

Table 4: Top 20 job skills in practitioner articles

Skill	Skill category	Times referenced
1. Security	Technical	62
2. Project Management	Technical	44
3. .Net	Technical	25
4. Java	Technical	23
5. LINUX	Technical	17
6. Networking	Technical	17
7. ERP	Technical	17
8. Wireless	Technical	15
9. Certification	Technical	15
10. Voice Over IP	Technical	14
11. Oracle	Technical	14
12. Windows	Technical	12
13. C++	Technical	12
14. Finance	Business	12
15. UNIX	Technical	11
16. System design	Technical	9
17. Systems analysis	Technical	9
18. XML	Technical	9
19. Work well in teams	Human	9
20. Company knowledge	Business	9

3.3 Job Skills Identified in Online Job Advertisements

The 241 jobs in our sample resulted in 5 humanistic (creativity, analytical, problem solving, dependability, hobbies), 17 technical (OO Programming, database, networking, MS Office, MS OS, MS Excel, SQL, Java, C++, C#, .Net, VB, XML, HTML, LINUX/UNIX, Project Management, SDLC methodology), and 7 business skills (leadership, communication, writing, organization, professional demeanor, teamwork, ability to work under pressure). These results are summarized in Table 5.

The most commonly advertised business and humanistic skills desired by employers includes communication, writing,

organization, problem solving, analytical ability, and ability to work in teams. These results largely confirm the results found in prior studies - companies are looking for versatile individuals who complete technical tasks, and also have the ability to communicate effectively to the business environment. A more interesting finding is that employers are explicitly seeking individuals who work within teams well. This skill is most commonly found in IT entry-level professionals across the company, from the Business Analyst realm to the Java Developer.

Technical Skills vary greatly based on the type of job that is being offered. Most of the Business Analyst/IT Analyst or IT Project Management type positions seek basic technical skills such as Programming Languages, Microsoft Office proficiency (especially Excel), and Project Management. The technical/programming job skills are tightly coupled with the job title. For instance, SQL Developers or Database Administrators usually need extensive knowledge in the SQL, Oracle or Microsoft SQL Server. Java Developers need knowledge in Java, JavaScript or J2EE and sometimes they need HTML, .NET, or XML knowledge. Web Developers commonly require HTML, Java, SQL, and/or XML knowledge. There is also a strong desire for Microsoft OS proficiency in various positions because of the work on different versions of Windows. In addition to the technical skills needed for the programming jobs, there was a strong desire for communication and teamwork as well.

Table 5: Skills found in Online Job Ads

Skill	Skill category	Times referenced
1. Communication	Humanistic	172
2. Writing	Humanistic	116
3. SQL	Technical	93
4. Ability to work in teams	Business	72
5. Organization	Humanistic	65
6. Java	Technical	63
7. Problem solving	Humanistic	62
8. Analytical	Humanistic	61
9. Database	Technical	61
10. Professional demeanor	Business	49
11. OO Programming Languages	Technical	44
12. Microsoft OS	Technical	42
13. .Net	Technical	42
14. Linux / UNIX	Technical	41
15. SDLC methodology	Technical	40
16. C	Technical	32
17. C#	Technical	32
18. Dependable	Humanistic	30
19. HTML	Technical	29
20. Ability to work under pressure	Business	26

3.4 Job Skills Across Academic, News, and Job Ads

The results presented above are synthesized and summarized to support a comparative analysis of job skills across the academic literature, practitioner literature and online job ads. For the humanistic skills in Table 6, job skills are consistent across the three data sources. However, the academic literature tends to identify the widest variety of sub-skills. For instance, reading comprehension, adaptability, ability to handle ambiguity, openness to new experiences, and ability to learn and teach new knowledge are only found in the academic literature.

Table 6: Humanistic Skills

Skill	Academic Literature	Practitioner Literature	Online Job Ads
Communication Skills	Yes	Yes	Yes
Reading comprehension	X		
Written communication	X	X	X
Oral communication	X	X	X
Interpersonal Skills	Yes	Yes	Yes
Work in teams	X	X	X
Negotiation skills	X	X	X
Leadership skills	X	X	X
Ability to learn / teach others	X		
Basic Work Skills	Yes	Yes	Yes
Proactive	X	X	
Dependable	X	X	X
Adaptable	X		
Ability to handle ambiguity	X		
Ability to work under pressure			X
Open to new experiences	X		
Creativity	X	X	X
Critical thinking	X	X	

For business skills (Table 7), the online job ads include the fewest sub-skills while the academic literature includes the most sub-skills. This difference is expressed most clearly in the business work skills category.

Table 7: Business Skills

Skills	Sub-Skills	Academic Literature	Practitioner Literature	Online Job Ads
Business Communication		Yes	Yes	Yes
	Presenta-tion skills	X	X	X
Business Interpers onal		Yes	Yes	Yes
	Customer relations	X	X	
Business Work		Yes	Yes	Yes
	Analytic ability	X	X	X
	Problem solving	X	X	X
	Understand business environment	X	X	
	Know-ledge of business functions	X	X	
	Ability to learn business functions	X		
	Understand organizati onal culture and politics	X	X	X
Others		Yes	No	Yes
	Ethics and profession alism	X		X
	Global awarenes s	X		

In the technical skills (Table 8), there is similarity across the broad categories such as MS Office and Operating Systems. However, differences emerge within the sub-skills. In the academic literature, sub-skills in newer technologies such as UML, JAVA and C# are not present. We surmise that many of these omissions occurred because much of the academic literature predates these newer technologies. Online job ads include the

skills that employers were seeking in the summer of 2008. Diverse programming skills were most in demand, while there were no ads seeking skills in ERP, service computing or Web 2.0 applications. The practitioner literature provides the most comprehensive list of technical sub-skills. We speculate that this occurs because much of the practitioner literature is forward looking and predicts new trends. Consequently, many of the newest technologies such as UML, Web 2.0, wireless networks, data mining and data warehousing are only found in the practitioner literature.

Table 8: Technical Skills

Skills	Sub-Skills	Academic Literature	Practitioner Literature	Online Job Ads
Operating Systems		Yes	Yes	Yes
	Microsoft OS	X	Xx	X
	Linux / Unix	X	X	X
MS Office		Yes	Yes	Yes
	Word	X	X	
	Excel		X	X
Business IT Solution		Yes	Yes	Yes
	Business process analysis / design	X	Xx	X
	Applica-tion develop-ment	X	X	
	Integrat-ing business applica-tions	X	X	
Network-ing		Yes	Yes	Yes
	LAN/WA N	X	X	
	Setting up networks		X	
	Wireless networks		X	
Systems Skills		Yes	Yes	Yes
	Gathering systems require-ments	X	X	

Skills	Sub-Skills	Academic Literature	Practitioner Literature	Online Job Ads
	Systems analysis	X	X	X
	UML		X	
	Systems design	X	X	
	Systems development	X	X	
	Systems auditing		X	
Program -ming		Yes	Yes	Yes
	COBOL	X	X	
	C#		X	X
	JAVA	X	X	X
	.NET		X	X
	Visual Basic	X	X	X
	HTML	X	X	X
	XML		X	X
Database		Yes	Yes	Yes
	SQL	X	X	X
	ORACLE	Xx	X	
	Data Modeling	X	X	
	Data Mining		X	
	Database Management	X	X	X
	Data warehousing		X	
Project Management		Yes	Yes	Yes
	Project budgeting		X	
	Project planning		X	
	Project risk management		X	
Web Development		Yes	Yes	Yes
Security		Yes	Yes	Yes

IT Architecture		No	Yes	Yes
ERP		No	Yes	No
Service Computing		No	Yes	No
Web 2.0		No	Yes	No
Others		Yes	No	No
	Ability to assemble new technology	X		
	Ability to learn new technology	Xx		
	Ability to understand technology trends	X		

4. CONCLUSION

This study enhances our knowledge about the skill sets required for IT workers. By comparing the job skills from the academic and practitioner literatures as well as job advertisements, our study helps to demonstrate both the similarities and differences across these three genres of texts. We found that the IS literature lags in terms of specific technical skills, but provides the richest understanding of humanistic and business skill sets. The practitioner literature tends to provide a forward-looking view of job skills, and has the richest set of technical skills. The online job advertisements are fairly balanced in terms of technical, humanistic and business skills.

5. ACKNOWLEDGMENTS

This material is based in part upon work supported by the □National Science Foundation under Grant Number HRD-0733747. Any opinions, findings, and conclusions or recommendations □expressed in this material are those of the author(s) and do not necessarily□ reflect the views of the National Science Foundation.

6. REFERENCES

- [1] Arnett, K. and Litecky, C. 1994. Career path development for the most wanted skills in the MIS job market," Journal of Systems Management, 45, 2, 6-10.
- [2] Prabhakar, B.K., Litecky, C.R. and Arnett, K. 1996. A longitudinal analysis of job skill trends in the MIS job market. In Proceedings of the Americas Conference on Information Systems, (Phoenix, AZ, August 16-18, 1996).
- [3] Todd, P.A., McKeen, J.D., and Gallupe, R.B. 1995. "The evolution of IS job skills: A content analysis of IS job ads, MIS Quarterly, 19, 1, 1- 37.
- [4] Litecky, C.R., Prabhakar, B.K., and Arnett, K.P. 1996. MIS job market: Shaken, but not stirred. Journal of Systems Management, July/August, 50-54.

- [5] Gallivan, M., Truex, D. and Kvasny, L. 2002. An analysis of the changing demand patterns for information technology professionals, In Proceedings of the ACM SIGCPR Conference, (Kristiansand, Norway, May 14-16, 2002), 1-13.
- [6] Gallivan, M., Truex, D. and Kvasny, L. 2004. Changing patterns in IT skill sets 1988-2003: a content analysis of classified advertising, *The DATABASE for Advances in Information Systems*, 35, 3, 64-87.
- [7] Leitheiser, R. 1992. MIS Skills for the 1990s: A survey of MIS managers' impressions, *Journal of Management Information Systems*, 9, 1, 69-91.
- [8] Trauth, E.M., Farwell, D.W., and Lee, D. 1993. The IS expectation gap: Industry expectations versus academic preparation, *MIS Quarterly*, 17, 3, 293-307.
- [9] Lee, D., Trauth, E.M., and Farwell, D.W. 1995. Critical skills and knowledge requirements of IS professionals: A joint academic/industry investigation, *MIS Quarterly*, 19, 3, 313-332.
- [10] Hardin, A.M., Joshi, K.D. and Li, X. 2002. Business as usual? IS job skill requirements during the internet era, In Proceedings of the Americas Conference on Information Systems, (Dallas, Texas, August 9-11, 2002), 2143-2150.
- [11] Dubie, D. 2008. Security skills of IT workforce lacking, survey finds, *Network World*, February 27, 2008. <http://www.networkworld.com/news/2008/022708-security-skills-it-workforce.html>.
- [12] Greenemeier, L. 2004. Linux going mainstream, *InformationWeek*, May 2004. <http://www.informationweek.com/news/software/operatingsystems/showArticle.jhtml?articleID=20900300>.
- [13] Hayes, F. 2002. Paradigm lost? *ComputerWorld*, 36, 39, (September 23, 2002). <http://www.adtools.com/9-23-02computerworld.pdf>.
- [14] Marsan, C.D. 2007. IT job skills that matter: Where you can leave a mark, *Network World*, December 12, 2007. <http://www.networkworld.com/etm/2007/122007-etm-jobs-matter.html>.