

Knowledge and Skill Requirements for Entry-Level Information Technology Workers: A Comparison of Industry and Academia

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ABSTRACT

Enrollments in Information Technology (IT)-related academic programs have declined significantly in recent years. Paradoxically, the U.S. Department of Labor predicts that the demand for IT professionals will grow much faster than the average for all occupations through the year 2016. To meet increasing demand, IT-related academic programs must attract more students and produce graduates who possess the technical, interpersonal and organizational knowledge and skills required of entry-level IT workers. The purpose of this study is to determine whether the importance of various skills for entry-level IT workers is perceived differently by faculty in academia than it is by IT managers in industry. The results reported in this paper are based upon a survey of the knowledge and skills required of entry-level IT workers as perceived by 350 IT managers and 78 faculty teaching in IT-related academic programs. Finally, implications of the survey results for faculty teaching in IT-related disciplines and for ongoing IT-related curriculum development, as well as implications for IT managers, are discussed.

Keywords: Information Systems (IS) skills, Information Technology (IT) skills, skill set, knowledge requirements, IS professionals, IT professionals, curriculum development

1. INTRODUCTION

Enrollments in Information Technology (IT)-related academic programs have declined significantly in recent years, (Granger, et al., 2007; Patterson, 2005; Pollacia and Russell, 2007). Several studies have investigated potential causes of the enrollment decline, attributing it most often to factors such as curriculum problems (Abraham, et al., 2006; Granger et al., 2007; McGann, et al., 2007), issues that influence students to choose (or not choose) an IT-related

major (Walstrom, et al., 2008; Zhang, 2007), lack of availability of accurate information about the IT industry and related employment opportunities to high school students (Lomerson and Pollacia, 2006), and offshore outsourcing of IT jobs (Rossheim, 2006; Tastle, et al., 2008).

The U.S. Department of Labor predicts that employment demand for IT-related professionals will grow much faster than the average for all occupations through the year 2016. For example, the Bureau of Labor Statistics projects that the number of jobs will increase 16% from 2006 to 2016 for the

occupation entitled “computer and information systems managers”, 37% for “computer scientists and database administrators”, and 53% for “network systems and data communications analysts” (Bureau, 2008a; Bureau, 2008b). It is also estimated that the United States will have only half of the qualified graduates needed to meet the rapidly increasing demand for IT professionals through 2012 because of the declining number of student enrollments (Longo, 2006).

To meet anticipated demand, it is urgent for IT-related academic programs to attract more students and prepare graduates with critical knowledge and skills. A number of studies have been conducted to determine the critical knowledge and skill sets that graduates need to perform IT-related jobs successfully, and whether there exists a perception gap between academicians and practitioners with regard to this required body of knowledge and skills (Cappel, 2001/2002; Doke and Williams, 1999; Kim, Hsu and Stern, 2006; Lee and Han, 2008; Lee, et al., 2002; Tang, Lee and Koh, 2000/2001; Trauth, Farwell and Lee, 1993).

In a recent study, the authors compared the perceptions of IT managers and IT workers with respect to the knowledge and skills needed for entry-level IT professionals (Aasheim and Williams, 2009). The purpose of this paper is to investigate whether the importance of various skills for **entry-level** IT professions is perceived differently by faculty in academia and IT managers in industry. The approach of this study is to conduct a survey of IT managers and faculty teaching in IT-related academic programs to examine their views on the knowledge and skills required of entry-level IT workers.

2. BACKGROUND

Despite the existence of model curricula for computing-related degree programs, several studies suggest that there is a gap between the skills achieved by Information Systems (IS)/Information Technology (IT) graduates and the skills required by employers (Cappel, 2001/2002; Kim, Hsu, and Stern, 2006; Lee and Han, 2008; Lee et al., 2002; Trauth, Farwell, and Lee, 1993; Doke and Williams, 1999; Tang, Lee and Koh, 2000/2001). These studies have examined this gap as it is perceived by IT professionals, academicians, students, and users. Some have made recommendations to improve the IS curriculum (Lee and Han, 2008; Lee, Trauth, and Farwell, 1995; Leitheiser, 1992; Trauth, Farwell and Lee, 1993; Young and Lee, 1996).

Lee and Han (2008) studied skill requirements for entry-level programmers/analysts in Fortune 500 companies and investigated the gap between the IS 2002 model curriculum and the requirements of the industry. They found that application development, software, 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 future IS curricula.

Surakka (2007), who extended previous studies by Lethbridge (2000a, 2000b), found that a decreased level of importance is being placed on continuous mathematics and basic science, and that new areas of emphasis, such as web-related skills, are emerging.

Fang, Lee and Koh (2005) found that personal/interpersonal skills were more important in new hires than core IS/IT skills and organizational knowledge. Both Surakka (2007) and Fang, Lee and Koh (2005) used a relatively small sample size, which leads to questions about the generalizability of their results.

Conversely, Abraham et al. (2006) found that technical skills were the most desired in new hires. They also reported that these technical skills were more likely to be outsourced and that the skills associated with the “business content” found in IS curricula were more likely to be retained in-house. The sample in Abraham et al. (2006) consisted of non-IT firms only and a proportionally larger share of Fortune 500 companies than is representative of the population of U.S. firms.

Kim, Hsu and Stern (2006) sampled employees at one manufacturing firm in the northeastern United States. They found that project management was the highest ranking skill, and that security, Enterprise Resource Planning (ERP) systems, end-user computing, and the integration of soft skills should be given more emphasis in IS curricula.

Gallivan, Truex and Kvasny (2004) examined skills listed in job advertisements and found that the skills listed there (mostly technical ones) were inconsistent with the “soft” skills organizations claimed were more important in new hires.

Although the recent studies discussed contribute to our understanding of the current knowledge and skills gap, the use of relatively small sample sizes and/or data extracted from job advertisements limits the generalizability of the findings.

3. METHODOLOGY

The primary purpose of this study is to determine whether there is a disconnect between the importance of various skills and traits for entry-level IT workers as perceived by IT managers versus faculty teaching in IT-related fields in academia. To this end, a survey was designed and administered to IT managers and to faculty teaching in IT-related degree programs.

The skill items in the survey were created by examining the Association for Computing Machinery (ACM) IT Curriculum (http://www.acm.org/education/curric_vols/IT_October_2005.pdf), the IS 2002 Curriculum from the Association of Information Systems (AIS) (www.aisnet.org/Curriculum/), and current empirical studies (Abraham et al., 2006; Fang, Lee and Koh, 2005). In addition, several demographic questions were added to the survey to gather information about the respondents and their respective organizations. The IT managers that participated in the survey were identified through an email list from a respected online survey company. The faculty participants were from the authors’ university or were asked to participate by the president of Association for Computing Machinery (ACM) Special Interest Group for Information Technology Education (SIGITE). SIGITE is an ACM special interest group that provides a forum for members of the field of information technology education to communicate and exchange ideas. The membership consists primarily of educators from universities and colleges.

A pilot study was conducted to test the questionnaire. The survey was administered to faculty, student workers and IT staff at the authors' university. Approximately thirty people participated in the pilot study. Feedback was gathered, leading to an improved version of the survey that was used in the data collection. The improvements include revision of the wording of some questions, reordering some questions, and deletion of a few questions as they were seen as redundant.

The final survey consisted of thirty-two skills/traits that participants were asked to rank in terms of importance on a scale of 1 (not important) to 5 (very important). A sample survey question is as follows:

Please rate on a scale of 1 to 5 (1 being "not important" and 5 being "very important") the following traits as they relate to full-time entry-level IT employees.

The skills/traits followed the above instructions. The survey was web-based and administered via email by a reputable online survey company. The rationale for this approach is that as faculty we do not have access to a wide spectrum of IT managers. Mailing (or emailing) several hundred surveys would likely have yielded 30-100 responses (assuming typical response rates). The survey company has a database of professionals that can be filtered by job type (such as IT manager). Utilizing this database gave us access to many more IT managers (and a much higher number of respondents) than could otherwise have been attained.

The survey company did not report a response rate. The survey was administered to IT managers and faculty in two separate data collection efforts. Responses were received from 391 IT managers and 86 faculty. Of these, 348 responses from IT managers and 78 responses from faculty were complete enough to use for analysis.

4. PROFILE OF RESPONDENTS

4.1 IT Managers

Responses were received from IT managers in all but six states in the U.S. Thirty percent (30%) of the respondents were from organizations with 10,000 or more employees while 25% had less than 500 employees. Approximately forty-four percent (44%) of the respondents work for organizations that have an IT staff with more than 100 employees and 21% had an IT staff of ten employees or less. The respondents represented a cross-section of industries with 23% working in the IT industry, 11% in education and 10% in health-care related industries. Table 1 provides a summary of the industries for the respondents.

Respondents were asked to identify IT areas or types of positions for which their organizations hire full-time entry-level IT workers. Respondents could check more than one area. The top three areas cited were help desk (70%), networking (56%) and programming (55%). The most common sources cited for finding entry-level IT workers were the web (48%) and internships (39%). Respondents could check more than one source. Table 2 summarizes the areas in which entry-level IT workers are hired and Table 3 summarizes the sources for finding those employees.

Industry	Percent
IT	23.3
Education	10.9
Health care related	10.1
Government/Military	8.3
Manufacturing	8.0
Financial	6.3
Retail	4.3
Insurance	3.7
Consulting (not in IT)	3.4
Transportation	3.4
Telecommunications	2.8
Non-Profit	1.7
Utilities	1.4
Other	12.6

Table 1: Respondents' Industries

IT Area	Percent
IT Help Desk	70%
Networking	56%
Programming	55%
Systems Analysis & Design	48%
Web Design & Development	46%
Database Area	44%
Clerical/Data Entry	29%
Other	9%

Table 2: Areas Entry-Level IT Employees are Hired

Source	Percent
Web	48%
Internships	39%
Newspapers	37%
IT department office	34%
Relatives/friends	24%
School's career planning office	24%
Co-op	13%
Instructors' recommendations	6%
Other	15%

Table 3: Sources for Finding Entry-Level IT Employees

IT managers were asked about the salaries of full-time entry-level IT workers. The average annual salary was approximately \$43,000 based on the input of the managers who knew these salaries. When IT managers were asked about the job market, they were fairly optimistic. Twenty-eight percent (28%) of managers perceived that the job market would improve in the future while 49% felt it would stay the same.

4.2 Faculty

Nineteen percent (19.2%) of responses were received from faculty in the state of Georgia (the authors' state of residence) and 80.2% were from outside the state of Georgia. The majority of respondents were at the rank of assistant (29%), associate (29%) or full professor (23%) with a few respondents at the rank of instructor (12%) and lecturer (6%). Respondents represented CS departments (23%), IS departments (19%) or IT departments (33%) as well as "other" departments (24%) including, but not limited to, Business Information Technology, Information

Management, Information and Logistics Technology, and Computer Information Systems. Faculty respondents varied in terms of teaching experience with 29% of respondents with more than twenty years of experience, 26% with ten to twenty years of experience, 33% with four to ten years of experience and 12% with three years of experience or less. It should be noted that since faculty respondents come from a variety of disciplines, ranging from programs that are more technical in nature to programs that are more managerial in nature, the faculty responses to the survey may vary across the disciplines.

5. DATA ANALYSIS AND RESULTS

Hypothesis tests were conducted for each of the thirty-two skills/traits included in the survey. For each skill/trait *i* (where *i* = 1, ..., 32), hypothesis *i* is:

H_i: There is no difference between faculty’s perceived average importance of skill *i* and IT managers’ perceived average importance of skill *i* for entry-level IT workers.

To test the hypotheses, independent samples t-tests were conducted. The common t-statistic assumes variances of the two populations are equal. Levene’s test, based on the F-distribution, is a hypothesis test for equality of variances. Where unequal variances are detected, the t-statistic for unequal variances should be used. The Levene test was used as opposed to the Bartlett test as it is less sensitive to departures from normality. SPSS provides both the t-statistic for the case when the populations are assumed to have equal variance and for the case when this assumption is violated (unequal variances). In the case where unequal variances were detected, the t-statistic for unequal variances was reported as opposed to the t-statistic for equal variances. (Hair et al. 1998). Table 4 provides a summary of the results.

The hypotheses are rejected in several cases, where the p-values in Table 4 are less than 0.05. Faculty and IT managers have differences in perceived average importance for the following skills/traits: communication, leadership, entrepreneurial/risk taker, high GPA, internship experience, work experience, database, operating systems, hardware concepts and packaged software concepts. Where the t-statistic is positive, IT managers place more importance on the skill/trait than faculty do.

To determine whether there was agreement among faculty and IT managers for general skill categories and for consistency with the methodology used in other IT skill studies, the authors combined the skills/traits into categories. In one common classification scheme, the four categories are: technical skills, organizational knowledge, personal skills/traits and interpersonal skills/traits (Fang, Lee and Koh, 2005; Tang, Lee and Koh, 2000/2001). Lee, Trauth and Farwell. (1995) used a slightly different classification of technical, organizational, IT management, and interpersonal/management knowledge/skills. The authors of this paper use a combination of the two approaches to arrive at four categories: (1) technical skills, (2) organizational and managerial knowledge/skills, (3) personal skills/traits and (4) interpersonal skills/traits. In addition, the survey gathered

data regarding the importance of work experience and grade point average (GPA) in hiring entry-level IT employees. Therefore, a fifth category called “experience and GPA” was added.

Skill/Trait	t-Statistic	p-value
Internship experience	-4.03	0.000*
Hardware concepts	3.49	0.001*
Operating systems	3.17	0.002*
Leadership skills	2.84	0.005*
Entrepreneurial/risk taker	2.50	0.013*
Database	-2.32	0.022*
High overall college GPA	2.16	0.032*
Communication skills	-2.13	0.035*
Packaged software	2.05	0.043*
Any work experience	2.04	0.044*
Creative thinking	1.63	0.103
Analytical skills	1.54	0.125
Co-op experience	-1.49	0.137
Organizational skills	1.49	0.137
Relevant work experience	1.35	0.179
Security	-1.04	0.299
Awareness of IT technology trends	-0.95	0.343
Systems development life cycle methodologies	0.93	0.351
Ability to work in teams	0.79	0.432
Knowledge of specific industry	0.79	0.431
Telecommunications/Networking	-0.68	0.497
Programming languages	0.62	0.535
Interpersonal skills	0.58	0.565
Extra-curricular activities	-0.57	0.572
Flexibility/adaptability	0.45	0.651
Knowledge of your company	-0.44	0.657
Web development programming languages	-0.42	0.672
Project management skills	-0.37	0.715
Knowledge of primary business functions	0.31	0.755
High IT GPA	-0.29	0.770
Honesty/integrity	-0.11	0.912
Motivation	0.00	1.000

* Significant at 5%

Table 4: Independent Samples t-Test for Equality of Means

Averages across categories were examined to determine if there was agreement about the importance of each category of skills/traits. Table 5 provides a summary of the skills/traits grouped by category as well as the mean for faculty and IT managers for each skill/trait and an overall average for each category. There is no difference between faculty’s perceived average importance for a skill category IT and IT managers’ average perceived importance for that skill category for entry-level IT workers based on a simple t-statistic at a 5% level of significance. In addition, both managers and faculty ranked the categories in the same order:

Skills Categories	Managers	Faculty
Technical Skills		
Awareness of IT technology trends	4.04	4.14
Operating systems	3.99	3.64
Telecommunications/Networking	3.90	3.96
Security	3.91	4.04
Hardware concepts	3.92	3.51
Database	3.92	4.14
Packaged software	3.82	3.54
Web development languages	3.85	3.90
Systems development life cycle methodologies	3.75	3.63
Programming languages	3.72	3.64
Average	3.88	3.81
Organizational and Managerial Knowledge/Skills		
Knowledge of primary business functions	3.65	3.62
Project management skills	3.65	3.69
Knowledge of your company	3.59	3.64
Knowledge of specific industry	3.50	3.40
Leadership skills	3.63	3.29
Average	3.60	3.53
Interpersonal Skills/Traits		
Communication skills	4.54	4.68
Ability to work in teams	4.49	4.42
Interpersonal skills	4.37	4.32
Average	4.47	4.47
Personal Skills/Traits		
Honesty/integrity	4.62	4.63
Analytical skills	4.51	4.37
Flexibility/adaptability	4.33	4.29
Motivation	4.37	4.37
Creative thinking	4.18	4.00
Organizational skills	4.13	3.97
Entrepreneurial/risk taker	3.21	2.87
Average	4.19	4.07
Experience and GPA		
Relevant work experience	4.06	3.91
Any work experience	3.83	3.58
High GPA in IT-related courses	3.50	3.54
Internship experience	3.40	3.83
High overall college GPA	3.34	3.13
Co-op experience	3.20	3.41
Extra-curricular activities	3.04	3.12
Average	3.48	3.50

Table 5: Skills Categories

1. Interpersonal skills/traits
2. Personal skills/traits
3. Technical skills
4. Organizational and managerial knowledge/skills
5. Experience and GPA

6. DISCUSSION

This study has examined whether the importance of various skills for entry-level IT workers is perceived differently by

faculty in academia and IT managers in industry. A survey of 350 IT managers and 78 faculty was conducted to examine their views on thirty-two skills/traits required of entry-level IT workers. The thirty-two skills/traits were drawn from IT/IS curriculum models and recent empirical studies. The results of the survey are twofold. First, when the thirty-two skills/traits are grouped (as is consistent with previous studies) into the broader categories of (1) technical skills, (2) organizational skills, (3) personal skills/traits, (4) interpersonal skills/traits and (5) experience and GPA, there

is no significant difference between faculty's and IT managers' perceived average importance. In addition, both IT managers and faculty ranked the importance of categories in the following decreasing order:

- a. interpersonal skills/traits,
- b. personal skills/traits,
- c. technical skills,
- d. organizational skills,
- e. experience and GPA.

This suggests that there is no disconnect between the relative importance of these skill categories for entry-level workers as perceived by IT managers and faculty teaching in IT-related disciplines. This is regarded as a positive finding for both IT faculty and IT managers as it implies that the emphasis being placed upon these broader categories of knowledge/skills in IT-related curricula is highly consistent with the expectations of IT managers. Our findings are also consistent with many other previous studies that cite personal/interpersonal skills as more important for entry-level workers than technical ones.

A second interesting finding of our study has to do with the perceived differences in importance of several individual skills/traits. Specifically, IT managers place more importance (in decreasing order) on the following skills/traits for entry-level workers than faculty do:

- a. hardware concepts,
- b. operating systems,
- c. leadership skills,
- d. entrepreneurial/risk taker,
- e. high overall college GPA,
- f. packaged software, and
- g. any work experience.

These differences have important implications for faculty teaching in IT-related disciplines and for the ongoing evolution of IT-related curricula. Our results suggest that these curricula should place more emphasis on skills that lie at both ends of technical/non-technical spectrum. For example, hardware concepts, operating systems knowledge and exposure to packaged software should be more heavily incorporated into the learning outcomes associated with IS and IT programs. At the same time, our findings indicate that these programs should also work toward helping students develop stronger leadership abilities and entrepreneurial attitudes and approaches. Clearly, the combination of both "soft" and "hard" skills will continue to be needed. Accordingly, IT-related programs need to address the manner in which this broad range of skills can effectively be covered within a typical four-year program of study. Our findings also suggest that faculty should continue to emphasize the importance of a high college GPA and the value of work and/or internship experience.

Conversely, one implication for IT managers is that entry-level IT workers are likely to need additional training on the hardware, operating systems, and packaged software programs used by their firms. Additionally, IT managers should consider extending professional development opportunities to entry-level workers to help them develop leadership abilities and entrepreneurial approaches.

Our findings indicate that faculty place more importance on internship experience than IT managers do. This is counter-intuitive and contradicts the finding that IT managers view "any work experience" as important. This contradiction may partially be explained by the fact that the survey did not specifically identify internship experience as an IT internship experience. In addition, many companies do not offer internships as they require a great deal of time and resources from the organization. Our findings also suggest that faculty place a higher level of importance on database knowledge/skills and communication skills than IT managers do. A possible explanation for the perceived difference in importance with respect to database skills may be that IT managers are more likely to associate these skills with IT workers who have a year or more of experience than with entry-level workers. The finding that faculty place more importance on communication skills than IT managers do is, at first blush, somewhat surprising. However, upon further reflection, the authors believe that the difference can be attributed to faculty recognition of the overall importance of personal/interpersonal skills for IT/IS graduates and the corresponding requirements for oral presentations and written reports across the entire college curriculum.

The primary limitation of our study stems from the fact that a relatively high percentage (19.2%) of faculty respondents were from the state of Georgia and that the sample size for faculty was relatively small as compared to that of IT managers. However, because many IT/IS programs are based upon widely accepted curriculum models and are accredited nationally and internationally by well-established accrediting agencies, the impact of the geographic composition of faculty respondents on the generalizability of our findings may be mitigated. Additional studies utilizing more faculty respondents from a broader range of geographic locations are needed to address this potential limitation.

Another limitation of our study is that the participants in the survey were asked to rank various skills/traits on a scale of 1 (not important) to 5 (very important). More refined information from the participants and a more precise analysis of the rankings of the skills/traits could be achieved with a finer scale (such as a 7-point scale).

7. CONCLUSION

At the individual skill level, faculty and IT managers perceive some differences in the relative importance of that skill for entry-level workers. Specifically IT managers place more importance than faculty do on hardware concepts, operating systems, leadership skills, entrepreneurial/risk taker traits, high overall college GPA, packaged software skills, and work experience.

However, when the broader categories of technical skills, organizational skills, personal skills/traits, interpersonal skills/traits and experience/GPA are considered, there is no significant difference between faculty's and IT managers' perceptions of average importance. Both groups ranked the importance of these categories in the following decreasing order: interpersonal skills/traits, personal skills/traits, technical skills, organizational skills, experience/ GPA. The primary finding of this paper is that there is no disconnect between faculty and IT managers with respect to the

perceived relative importance of these skill categories for entry-level workers.

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