Analysis of Skills Requirement for Entry-Level Programmer/Analysts in Fortune 500 Corporations

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ABSTRACT

This paper presents the most up-to-date skill requirements for programmer/analyst, one of the most demanded entry-level job titles in the Information Systems (IS) field. In the past, several researchers studied job skills for IS professionals, but few have focused especially on "programmer/analyst." The authors conducted an extensive empirical study on programmer/analyst skill requirements by collecting and analyzing 837 job ads posted on Fortune 500 corporate websites for three years. The results indicate that the programmer/analysts in the Fortune 500 are expected to fulfill a combination of roles from computer program writers to technical experts as well as businessmen. The results of this study are discussed in terms of their implications for the IS 2002 curriculum model.

Keywords: Programmer/Analyst, Job Skill, Job Ads, Fortune 500, IS 2002 Curriculum

1. INTRODUCTION

The ongoing transformation in the nature of required job skills has been driven by sweeping changes in new technologies as well as by competition among companies driven to innovate by continuously upgrading and differentiating their products and services. This phenomenon has led IS workers to constantly move from one set of skills to another to cope with both business and technological changes. An important change that occurred within the IS field was the repositioning of its role from being merely a back office supporter to a strategic opportunity creator (Agarwal and Ferratt, 2001; Fusaro, 2001; Moore and Burke, 2002). Accordingly, this change has led organizations to look for IS professionals who have not only the highly-demanding, up-to-date skills for utilizing new technologies but also suitable skills for accomplishing organizational goals. This trend explains why many organizations continuously seek out well-trained IS graduates regardless of any downward trends in our economy or offshore outsourcing.

IS programs in higher learning institutions have long trained students to develop the appropriate skills needed for their future careers. Nevertheless, most business organizations are still under a difficulty in finding IS graduates who possess both the knowledge and skills best suited to their specific needs. Many researchers (Tang, Lee, and Koh, 2000; Lee, Nielsen, Trauth, and Venkatesh, 2000; Weber, McIntyer, and Schmidt,, 2001) assert that IS education programs are not in harmony with the requirements of the real world.

Dynamic IS trends coupled with an ever-changing competitive business environment make it difficult for IS education programs to satisfy the newly evolving skill requirements of business organizations. Identifying the right skills is very much akin to shooting at a moving target rather than a static one. Thus, a periodical review of up-to-date skills required for IS professionals is a necessary responsibility of IS researchers as a bridge between IS professionals and IS students.

As an effort to understand knowledge and skill requirements with volatile trends in IS, this research collected and analyzed 837 job ads looking for an entry-level IS specialist titled "programmer/analyst" for Fortune 500. To assess how well IS education programs are designed to reflect the real world scenarios, the authors

conducted a comparative analysis between the skill requirements found in this research and the topics included in the IS 2002 curriculum model. In this study the authors focus on programmer/analysts because it has been the most frequently occurring job in terms of total number of ads in the IS job market (Gallivan, Truex, and Kvasny, 2004) and it speaks for the trends of combination of business and technical skill requirements in IS job market.

2. PROGRAMER/ANALYST AS AN ENTRY-LEVEL IS SPECIALIST

While the programmer tends to fill programming jobs that have been directed by systems designers, the programmer/analyst as a profession is responsible for analyzing businesses and developing software applications using programming languages. As a result, programmer/analysts with a dual proficiency are thought to be working with systems analysts to design information systems and use programming languages such as C++, Visual Basic, or Java to develop applications with which end-users can access. Bureau of Labor Statistics (2004-2005) mentions that programmer/analysts increasingly work with databases, object-oriented programming languages, and client–server applications development as well as multimedia and Internet technology.

Several empirical studies have proven that the role of programmers has changed. A historical review of the skills required for programmers between 1970 and 1990 revealed that even though requirements of technical skills had been obvious, the importance of behavioral ones had increased (Todd, McKeen, and Gallupe, 1995). Recent empirical studies have shown, however, that it was also important for programmers to possess behavioral skills such as communication (Chen, Frolick, and Muthitacharoen, 2003), critical thinking (Davis, 2003), and business knowledge (Noll and Wilkins, 2002; Cheney and Lyons, 1980). As organizations require their IT staff to become more business-partner oriented rather than to remain mere technicians, it is observable that programmers cannot carry out their programming work without communicating with users and clients to understand their business requirements. In a nutshell, more people in programmer jobs are now required to possess behavioral skills and business knowledge on top of their technical skills. Consequently, it becomes clear why organizations seek out programmer/analysts more than pure programmers or pure analysts.

From research that collected and analyzed job ads from three different years (1988, 1996, and 2001), Gallivan and his colleagues (2004) reported that the programmer/analyst was the most frequently-occurring job in terms of total number of ads in the IS job market. The popularity of the programmer/analyst job title can be considered a response to the changing environment. Since IS professionals are required to understand business processes and integrate them into technology-based solutions, the role of IS professionals has gradually changed from that of a programming code writer to that of a business partner (Markus and Benjamin, 1996; Nelson and Cooprider, 1996; Davis, 2003).

To summarize, the job title "programmer/analyst" seems to be more popular for current entry-level IS professionals who are capable of analyzing and translating business requirements into business applications. Many previous studies have attempted to identify the requisite knowledge and skills for other IS job titles such as IT manager (Todd, McKeen, and Gallupe 1995, Richards, Yellen, Kappelman, and Guynes, 1998), systems analyst (Lee, 2005a; Green, 1989), and programmer (Noll and Wilkins, 2002). Although programmer/analysts play a very important role in developing software applications in all types of organizations, few studies have yet focused on this job title.

3. RESEARCH METHODOLOGY

3.1 Research Questions

The research questions of this study are to:

1. Identify the skill requirements for entry-level programmer/analysts in Fortune 500 corporations, and
2. Compare the results to the IS 2002 curriculum by mapping the identified skill requirements with the topics for suggested courses in the curriculum.

3.2 Research Design and Analysis Method

As a data source, job ads from Fortune 500 corporate websites were chosen to investigate the skill requirements for entry-level programmer/analysts for the large corporations. Researchers studying IS skills (e.g., Litecky and Arnett, 2001; Maier, Greer, and Clark, 2002; Gallivan, Truex, and Kvasny, 2004) have used job ads to identify the skill requirements. Most previous IS skill studies, with few exceptions (e. g., Lee, 2005a; Lee 2005b), did not collect data selectively from big corporations even though IS workers, as Jiang et al. (2001) found, prefer to work for big and prestigious companies due to their identity and technical competence.

Commercial job boards such as Monster.com and Hotjobs.com are likely to be used by small- and medium-sized firms that usually do not attract enough traffic from job seekers. However, big corporations that belong to the Fortune 500 are not willing to use commercial job boards for recruiting (Lee, 2005a). More than eighty percent of the Fortune 500 companies announce job openings on their own corporate websites rather than on commercial job boards such as Monster, Careerbuilder, or Hotjobs (iLogos Research, 2002).

Content analysis was used to determine skill requirements in the ads for programmer/analysts. For the analysis, this research adopted Lee's (2005a) categorization, which was a modification of Todd et al's (1995) categories. As previous researchers have developed their own skill categories with which to analyze job ads, Lee (2005a) developed eight skill categories adapted from the seven categories proposed by Todd and his colleagues (1995). The significant difference between Lee's model (2005a) and Todd et al.'s (1995) was the dividing of the hardware category into two categories, architecture/network and hardware. The new category, architecture/network, includes networking knowledge/skills such as the Internet and e-business which reflects the time gap between the mid 1990's and the early 2000's. Separating architecture/network from hardware was in lieu with the change of the

IS 2002 curricula from the 1997 version. From a survey conducted on the IS 1997 version, Longenecker and his colleagues (2001) identified an Internet-based course as a missing element in the curricula. As shown in Table 1, the authors for this study adopted eight categories proposed by Lee (2005a).

Different computing methods could be applied to present the results. Typically, job ads mention specific skills in the form of either words or phrases. A dictionary was thus developed to assign words or phrases to a specific skill. As suggested by Todd et al. (1995), the authors also developed a coding sheet, as shown in Table 4, to assign a value of either "0" or "1" to each of the specific skills. A value of "1" was assigned to an ad if any word or phrase for a specific skill was mentioned at least once in the ad. A value of "0" was assigned otherwise. To secure the reliability of the skill dictionary, this research coded 200 randomly-chosen samples with the help of a group of three MIS doctoral students. Among three coders, the agreement level of the coding completed by the coders was more than 90 percent, and disagreements were resolved with one of the authors until the coders arrived at consensus.

3.3 Data Collection

Over the three year period from 2001 to 2003, eight-hundred thirty-seven job ads for programmer/analysts were collected from the Fortune 500 corporate websites: 117 ads in 2001, 412 in 2002, and 308 in 2003. Only full-time jobs were collected; part-time jobs and temporary or contract-based positions were excluded. It should be noted that only job ads containing the title "programmer/analyst" were included as shown in Table 2. Ads for the job such as scientific programmer, computer programmer, or business analyst that did not include both "programmer" and "analyst" as job titles were excluded for this analysis. Table 3 shows the industry classifications of the firms in the sample. The distribution of job ads by state, analyzed by 41 states and Washington, D. C. is shown in Table 3 on the next page.

4. RESULTS

4.1 Basic Analysis

The basic analysis was performed to observe qualification requirements for education and professional certification. From the applicant's point of view, the basic requirements are explicit and necessary conditions to apply for the job.

While 589 (70.4%) of the 837 job postings collected specified minimum education requirements that should be met by potential candidates, 248 (29.6%) did not. Of the 589 ads, the majority (566 ads: 96.1%) were seeking people who held at least a bachelor's degree (95.1%) or higher (1.0%). Only a small percentage of ads mentioned that they accept applications from high school diploma holders (9 ads: 1.5%) or associate degree holders (13 ads: 2.2%). The trend of seeking applicants with at least a bachelor's degree might be due to the fact that the job ads collected were limited to Fortune 500 corporations. The message to job applicants, however, was clear: IS job applicants with high school diplomas or associate degrees could hardly anticipate to be hired by the Fortune 500.

	Architecture / Network							**Hardware**					**Software**							**Business**							**Management**								**Social**			**Problem Solving**								**Development**								
Specific Skills	General Architecture/Network	Client/Server	Internet	Mainframe	Networking & N/W Devices	Network Security	Server	Devices/Printers/Storage	Desktop/PC	General Knowledge of Hardware	CASE	Database	OS/Platforms	Programming Language	General Knowledge of Software	Electronic Business	Enterprise-wide	Function Specific	Industry specific	General Knowledge of Business	Leadership	Monitor & Control	Organization	Planning	Project Management	Training	General Knowledge of Management	Communication	Independent / Self-Motivated	Interpersonal	Adaptive / Flexible	Analytic / Critical / Logic	Creative / Innovative	Customer-Oriented	Modeling	Quantitative	Technical Expertise	General Knowledge of Problem Solving	Analysis	Design	Documentation	Implementation	Integration	Knowledge of Methodology	Knowledge of general technological trends	Operation/Maintenance	Programming	Quality Assurance
Ad #001																																																			
Ad #002																																																			
Ad #003																																																			
...																																																			
Ad #837																																																			

Table 1. Data Coding Sheet

Job Title	Number of Ads	Percentage
Programmer/Analyst	653	78.0 %
System Programmer/Analyst	99	11.8 %
Computer Language Programmer/Analyst	53	6.4 %
Application Programmer/Analyst	32	3.8 %
Total	837	100.0 %

Table 2. Percentage of Job Titles Collected

Industry	Number of Ads (%)	Number of Companies (%)
Information, Finance, Insurance, & Professional	326 (39.0%)	67 (33.2%)
Manufacturing	185 (22.1%)	61 (30.2%)
Retail, Wholesale, Transportation, & Warehousing	176 (21.0%)	38 (18.8%)
Education, Health Care, & Social Assistance	89 (10.6%)	16 (7.9%)
Mining, Utility, & Construction	32 (3.8%)	9 (4.5%)
Arts, Accommodation, & Food Services	29 (3.5%)	11 (5.4%)
Total	837 (100%)	202 (100%)

Table 3. Number of Sample Job Ads by Industries

State	Number of Ads	State	Number of Ads
California	101 (12.1%)	Massachusetts	26 (3.1%)
Illinois	96 (11.5%)	Tennessee	23 (2.7%)
Virginia	54 (6.5%)	Arkansas	22 (2.6%)
New Jersey	53 (6.3%)	Washington	21 (2.5%)
Texas	52 (6.2%)	North Carolina	17 (2.0%)
Ohio	49 (5.9%)	Michigan	16 (1.9%)
Georgia	43 (5.1%)	Maryland	15 (1.8%)
Florida	42 (5.0%)	Missouri	15 (1.8%)
New York	42 (5.0%)	Other 23 States and DC	118 (14.1%)
Pennsylvania	32 (3.8%)	Total	837 (100%)

Table 4. Sample Job Ads by State

The ever-changing, fast-paced IS environment does not seem to appreciate generally accepted certifications (Linderman and Schiano, 2001) despite studies having shown that certifications make a positive impact on employers (Anderson, Barrett, and Schwager, 2002; Ray and McCoy, 2002). In fact, Prabhakar and his colleagues (2005) have recently reported that an average of 5% of all positions advertised required vendor or industry certifications, and they inferred that a tough job market seems to put more importance on certifications. The authors of this study also found that only 41 ads (4.9%) of the 837 ads from the Fortune 500 mentioned certifications. This limited advantage mainly comes from software giants such as Microsoft and Oracle. The figure 5%, however, is held in doubt as a sufficient percentage for determining whether or not certifications are important to job applicants.

4.2 General Trends of Skills Needed for Programmer/Analysts

From development to hardware, as shown in Table 5, each of the specific skills was calculated by counting the number of ads that mentioned the skill at least once. Using the same method, the authors calculated the number of ads for each category by counting the ads that mentioned any of the specific skills under the category at least once in the ad. Figure 1 depicts the numerical results obtained by extracting each of the eight skill categories.

Seven out of eight categories, with the exception of hardware, were mentioned at least once in more than 60 percent of the ads collected. In general, this result is consistent with previous studies; e.g., an IS professional should be an all-round player (Arnett and Litecky, 1992 and 1994; Lee, 2005b).

Skills related to development (98.7%), software (98.3%), business (83.3%), and social abilities (82.9%) were highly required by Fortune 500 corporations.

4.3 Programmer/Analyst as a Software-Oriented Developer

Although the programming requirement (93.2%) was obvious for programmer/analysts, many other skills listed under the development category were mentioned in more than half the job ads collected. The five skills that

received significant attention from the Fortune 500 were general knowledge of development (75.5%), implementation (74.3%), operation/maintenance (73.7%), design (70.5%), and analysis (67.5%). Much attention was also given to both documentation (45.6%) and knowledge of development methodologies (40.6%). The role of programmer/analysts does not remain within the programming realm, but they are rather expected to play a role as IS developers.

Database was found to be an important software skill for programmer/analysts (78.5%). Oracle was obviously dominating the market of database management systems among Fortune 500 corporations. Phrases related to Oracle, SQL-Server, and Sybase were found in 231 (27.6%), 88 (10.5%), and 31 job ads (3.7%), respectively. The competition between Unix (27.0%) and Windows-NT (26.9%) seems very keen in the Fortune 500. AS/400 (12.3%) also appeared to depend on its own small part of the Fortune 500 market.

The demand for general knowledge of software needs to be compared to the demand for general knowledge of hardware. While four out of ten job ads referred to general knowledge of software (41.3%), only one out of ten ads referred to general knowledge of hardware (10.9%), which indicates that programmer/analysts in Fortune 500 corporations must be more software-oriented than hardware-oriented. In the same venue, none of the sub-categories in both architecture/network and hardware categories was mentioned by more than 40 percent of the total job ads. This phenomenon of the low demand for hardware skills could be explained by the trend of recent years. First, the tremendous improvement of interfaces between users and desktop/PC and peripheral devices may have reduced the hardware workload for IS workers. For example, most end-users today have enough knowledge to fix minor problems with their desktop/PCs. Second, many Fortune 500 corporations might have outsourced the responsibility of hardware maintenance to their external partners.

Development	826	98.7%
Programming	780	93.2%
General Knowledge of Development	632	75.5%
Implementation	622	74.3%
Operation/Maintenance	617	73.7%
Design	590	70.5%
Analysis	565	67.5%
Documentation	382	45.6%
Development Methodologies	340	40.6%
Integration	166	19.8%
Knowledge of Technologic Trends	132	15.8%
Quality Assurance	114	13.6%
Software	**823**	**98.3%**
Programming Language	726	86.7%
Database	657	78.5%
Operating Systems / Platforms	515	61.5%
Packages	395	47.2%
General Knowledge of S/W	346	41.3%
CASE	19	2.3%
Business	**697**	**83.3%**
General Knowledge of Business	635	75.9%
Function specific	573	68.5%
Industry specific	227	27.1%
Enterprise-wide	191	22.8%
Electronic Business	40	4.8%
Social	**694**	**82.9%**
Interpersonal Skills	552	65.9%
Communication Skills	544	65.0%
Independent/Self-Motivated	234	28.0%

Problem Solving	647	77.3%
Technical Expertise	297	35.5%
General Problem Solving	294	35.1%
Adaptive / Flexible	253	30.2%
Analytical / Critical / Logical	237	28.3%
Customer-Oriented	205	24.5%
Modeling	78	9.3%
Quantitative	54	6.5%
Creative/Innovative	51	6.1%
Management	**562**	**67.1%**
Organization Skills	230	27.5%
Planning	207	24.7%
Leadership Skills	164	19.6%
Project Management	158	18.9%
Training	151	18.0%
General Knowledge of Management	124	14.8%
Monitor and Control	115	13.7%
Architecture/Network	**548**	**65.5%**
Internet	296	35.4%
General Knowledge of Arch./Network	177	21.1%
Client/Server	147	17.6%
Mainframe	129	15.4%
LAN/WAN Networking & N/W Devices	104	12.4%
Security	33	3.9%
Hardware	**357**	**42.7%**
Server	255	30.5%
General Knowledge of H/W	91	10.9%
Desktop/PC	63	7.5%
Devices/Printers/Storage	30	3.6%

Table 5. Number of Ads Showing Frequency of Skills

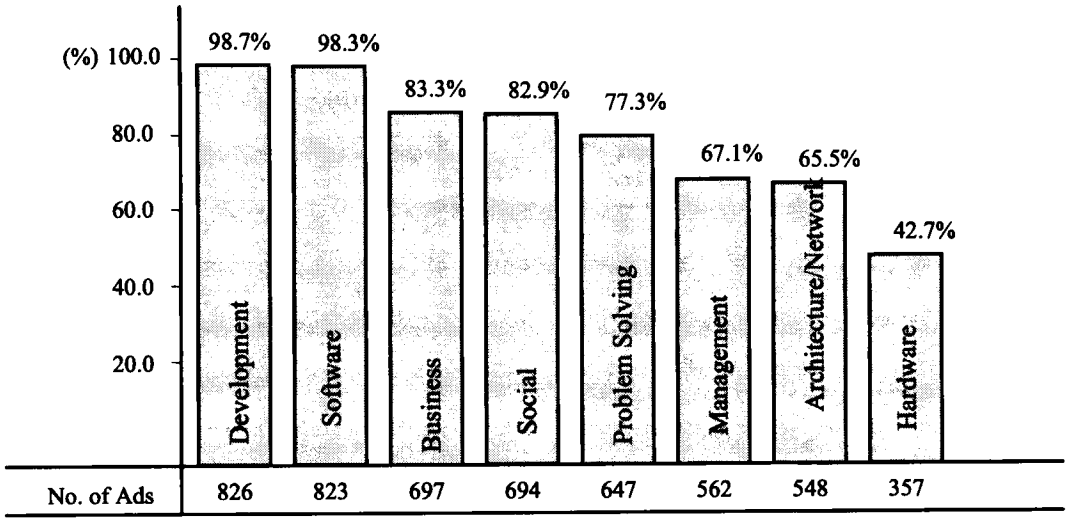

Figure 1. Percentage of Ads that Referred to Each Category at Least Once in the Ad

Of the eight specific skills under the architecture/ network category, the Internet-related skills (35.4%) such as Web or Intranet were relatively highly needed for programmer/analysts. It should be noted that the requirements for Local Area Network/Wide Area Network (LAN/WAN) skills were relatively low (12.4%). In addition, only 3.9 percent of job ads referred to security-related skills such as network security, data security, and firewalls. Programmer/analysts do not seem to be heavily responsible for the architecture and network-related tasks that are supposedly performed by people in other job titles such as network administrator or network analyst.

4.4 Is COBOL Still Alive?

A detailed view of programming languages being used by Fortune 500 corporations is provided in Table 6. While both C (9.8%) and C++ (14.8%) seem to be strong in their market, programmer/analysts who are capable of doing Java programming (30.7%) are most likely to be hired. This result is also consistent with the report from a trade journal (Radcliff, 2001). Some doubts have been raised as to whether COBOL, a traditional and procedural programming language used to maintain legacy systems, is worth learning. Surprisingly, COBOL was mentioned in 193 ads (23.0%), which implies that COBOL is still alive and is being used by a number of Fortune 500 corporations. Previous surveys (e.g., Fryer, 1999; Goff, 2000) also illustrated that obtaining old language skills such as COBOL and C++ is still sought and very necessary for programmer/analysts. Three main visual programming languages are Visual Basic (26.6%), which is the leader, Powerbuilder (3.6%), and Delphi (2.2%). Report Program Generator (RPG) was mentioned in 6.5 percent of the ads for programmer/analysts.

Client/server and mainframe have been two of the most popular architectural designs. The degree to which client/server (17.6%) skill was required for programmer/analysts is similar to the degree to which mainframe (15.4%) skill was required.

This denotes that Fortune 500 corporations maintain their mainframe computers. With the warning of the mainframe skill shortage by researchers (Fox, 2002) and the numbers on the importance of mainframe and COBOL skill having been proven to some degree, it might be too early for IS education institutions to discontinue offering courses on mainframe programming.

Programming Language	Number of Ads (Total:622)
Java	257 (30.7%)
Visual Basic	223 (26.6%)
COBOL	193 (23.0%)
C++	124 (14.8%)
C	82 (9.8%)
RPG	54 (6.5%)
Powerbuilder	30 (3.6%)
Delphi	18 (2.2%)

Table 6. Programming Language Skills

4.5 Programmer/Analyst as a Businessman

General knowledge of business (75.9%) was a clear requirement for programmer/analysts by the Fortune 500. Functional knowledge including human resource management, marketing, finance, etc. was also mentioned in 68.5 percent of the job ads.

It is quite surprising that programmer/analysts are required to understand various business functions as well as general business. More than a quarter (27.1%) of job ads mentioned industry-related words while more than twenty percent referred to enterprise-related words. In addition, this result seems to be at least somewhat related to the adoption of Enterprise Resource Planning (ERP) systems such as SAP, Peoplesoft, and One World. ERP software in particular has saturated the market of Fortune 500 corporations (Rosa, 1998). However, electronic business drew little attention in

that only 4.8% of job ads mentioned "electronic business" or "electronic commerce." Very few ads for programmer/ analysts, which are very technically-oriented, mentioned most of the skills under the category of management. It is noteworthy that 27.5 percent of ads mentioned organization skills.

The IS field has been constantly changing, and IS professionals must be flexible to adapt to new environments. About one-third (30.2%) of programmer/analyst ads used vocabulary "adaptive" or "flexible." In the same setting, more than thirty percent (35.5%) of the job ads mentioned the phrase "technical expertise," and 28.3 percent mentioned words such as analytical, critical, or logical. A quarter of the ads contained phrases related to being customer-oriented. However, modeling skills such as goal programming, simulation, and forecasting were mentioned in 9.3 percent, which is less than one out of ten ads. In the real world, programmer/analysts might not be required to do modeling. The low demand in the Fortune 500 for modeling skills might be related to the low demand (2.3%) for CASE tools, which are most likely to be used to do modeling.

As a matter of fact, this result is consistent with previous studies undertaken by Todd, et al. (1995), which found that CASE tools were mentioned only in 11 out of 171 ads for programmers. Guinan et al. (1997) also found that CASE tool usage was much lower than expected.

4.6 Technical vs. Behavioral

The importance of behavioral skills relative to technical skills has long been one of the primary issues for IS researchers.

While empirical studies (e. g., Nunamaker, Couger, and Davis, 1982; Cheney, Hale, and Kasper, 1990; Landry, Longenecker, Haigood, and Feinstein, 2000) on one side have found behavioral skills to be more important than technical skills, other studies (e.g., Vitalari, 1985) make the opposing argument in favor of technical skills. Some other studies argue that IS professionals must possess both behavioral and technical skills (Burgess and Chikofsky, 1992; Kwak, 2001; Wright, 2001). However, most researchers and practitioners seem to agree that behavioral skills have become increasingly important as IS professionals climb up the career ladder from programmer/analysts to systems analysts or IT managers (2005). From this data analysis, the job performed by programmer/analysts has been considered to be more technical than behavioral.

Most Fortune 500 corporations expect their programmer/analysts to be heavily involved in development activities using software-related skills. For example, such development and software skills as programming (93.2%), programming languages (86.7%), database (78.5 %), general knowledge of development (75.5%), implementation (74.3%), and operating systems/platforms (61.5%) were highly required for programmer/analysts. Many skills that belong to the behavioral category, however, also demanded much attention. For example, both interpersonal (65.9%) and communication (65.0%) skills were mentioned in more than 60 percent of the ads collected. Consequently, although technical skills must be very critical for job-seeking programmer/analysts, behavioral skills should not be ignored to successfully fill potential positions.

4.7 Implications for the IS Curriculum

As suggested earlier, another interest of this study was to investigate the gap between the contents of the IS model curriculum and the requirements of the industry. Unfortunately, IS education programs have been criticized not to be in harmony with the requirements of the real world (Trauth, Farwell, and Lee, 1993, Tang, Lee, and Koh, 2000; Weber, McIntyer, and Schmidt, 2001). Because this study collected entry-level job ads, it is very valuable and practical to use this data to compare to IS curriculum models.

The IS 2002 model curriculum (http://www.is2002.org) was developed by several organizations: the Association for Computing Machinery, the Association for Information Technology Professionals, and the Association for Information Systems. The model curriculum presents eleven courses, as shown in Table 7, that range from Personal Productivity with IS Technology (IS 2002.P0) to Project Management and Practice (IS 2002.10).

The model curriculum organizes IS topics by courses, and some topics could be covered in more than one course. Although the model curriculum has provided the topics for each of the eleven courses, the same course might be taught in different ways by different instructors at different institutions. For this reason, during this mapping process, only the simple words and phrases describing topics were abstracted and compared with the specific skills in Table 5. Andrews and Wynekoop (2004) have also used the summary of topics as a tool for investigating the value of IS core courses to accounting majors. As shown in Table 8, the authors mapped the model curriculum to the identified skill requirements for the programmer/analyst's job sought by Fortune 500 corporations. The authors attempted to link the specific skills with the topics suggested by each of the eleven courses.

Most topics of the model curriculum seem to be matched with the skills identified from this research. Such italicized skills in Table 8 as knowledge of technological trends and function-specific knowledge were the ones uncovered in the topics proposed by the IS 2002 model curriculum. Skills under the business and social category could hardly be covered in IS courses. Knowledge of business functions and industries could be covered in business courses, and in fact, most IS programs have been requiring IS majors to take business courses such as marketing, human resources, and finance. Skills that seem to deserve attention from the designers of the future IS model curriculum are quantitative, creative/innovative, knowledge of technological trends, general problem solving, adaptive/flexible, and mainframe. These missing links should be connected by adding relevant topics to the IS model curriculum.

Conversely, such topics in the model curriculum as legal and ethical aspects of IS were hardly found in the skill requirements for the programmer/analyst's jobs in the Fortune 500. In addition, while IS 2002.4 covers both hardware and operating systems, topics under this course may require re-thinking because few organizations appear to be interested in hardware-related skills. Even though instructors will no doubt continue teaching the basic

concepts of hardware, the results of this research suggest that the emphasis of IS 2002.4 be put more on servers and operating systems rather than the tangible hardware such as CPU, storage devices, and monitors.

5. CONCLUSIONS

Despite many previous studies on the issue of IS skills, this study attempts to understand the nature of a programmer/analyst's job by analyzing job ads from Fortune 500 corporate websites. The main purpose of this research is to identify skills necessary for the programmer/analyst as an entry-level job title rather than for programmers and analysts separately. For this research, 837 job ads were collected directly from the Fortune 500 corporations' websites. This dataset constitutes a unique contribution within IS research because it reflects the requirements for entry-level programmer/analysts from the large corporations while most previous studies analyzed the job ads of small- and medium-sized firms in the newspaper or commercial job boards.

Overall, skills related to development, software, social skills, and business were highly required for programmer/analysts by these large corporations. Relatively less attention was given to skills under the categories of architecture/network, hardware, management, and problem solving. This study found that some skills should be taken into account by the designers of the future IS curriculum. In addition, it would be very interesting if skills requirements from small companies can be compared with skills requirements from the Fortune 500.

This study is expected to contribute to longitudinal observations of change in skills requirements by collecting data continuously. Skill requirements research should be conducted periodically to help IS educators redesign IS curriculum and courses and better prepare IS graduates for their future in the field.

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3. IS 2002 .2 – Electronic Business Strategy, Architecture, and Design
4. IS 2002 .3 – Information Systems Theory and Practice
5. IS 2002 .4 – Information Technology Hardware and System Software
6. IS 2002 .5 – Programming, Data, File and Object Structures
7. IS 2002 .6 – Networks and Telecommunication
8. IS 2002 .7 – Analysis and Logical Design
9. IS 2002 .8 – Physical Design and Implementation with DBMS
10. IS 2002 .9 – Physical Design and Implementation in Emerging Environments
11. IS 2002 .10 – Project Management and Practice

Table 7. Eleven Courses of IS Model Curriculum

	Skill Requirements	# of Job Ads	% of Job Ads	IS 2002 Courses
Development	Programming	780	93.2%	IS2002 .1 5
	General Knowledge of Development	632	75.5%	IS2002 .3 7 9
	Implementation	622	74.3%	IS2002 .1 2 7 8 9 10
	Operations/Maintenance	617	73.7%	IS2002 .4 9
	Design	590	70.5%	IS2002 .P0 1 2 3 .5 7 8 9 10
	Analysis	565	67.5%	IS2002 .2 7 10
	Documentation	382	45.6%	IS2002 .7
	Development Methodologies	340	40.6%	IS2002 .7
	Integration	166	19.8%	IS2002 .7 10
	Knowledge of Technological Trends	132	15.8%	--------
	Quality Assurance	114	13.6%	IS2002. 1 3 9
Software	Programming Language	726	86.7%	IS2002 .1 IS2002.5
	Database	657	78.5%	IS2002 .0 1 7 8 10
	Operating Systems / Platforms	515	61.5%	IS2002 .4
	Packages	395	47.2%	IS2002 .1 7 P0
	General Knowledge of S/W	346	41.3%	IS2002 .P0 1 4
	CASE	19	2.3%	IS2002 .7 8
Business	General Knowledge of Business	635	75.9%	IS2002 .2
	Function specific	573	68.5%	--------
	Industry specific	227	27.1%	--------
	Enterprise-wide	191	22.8%	IS2002 .7
	Electronic Business	40	4.8%	IS2002 .2
Social	Interpersonal Skills	552	65.9%	IS2002 .7
	Communication Skills	544	65.0%	IS2002 .7
	Independent/Self-Motivated	234	28.0%	--------
Problem Solving	Technical Expertise	297	35.5%	IS2002 .10
	General Problem Solving	294	35.1%	--------
	Adaptive / Flexible	253	30.2%	--------
	Analytical / Critical / Logical	237	28.3%	IS2002 .7 10
	Customer-Oriented	205	24.5%	IS2002 .10
	Modeling	78	9.3%	IS2002 .2 8
	Quantitative	54	6.5%	--------
	Creative/Innovative	51	6.1%	--------
Management	Organization Skills	230	27.5%	IS2002 .10
	Planning	207	24.7%	IS2002 .2 3 7
	Leadership Skills	164	19.6%	IS2002 .10
	Project Management	158	18.9%	IS2002 .7 10
	Training	151	18.0%	IS2002 .9
	General Knowledge of Management	124	14.8%	IS2002 .2 3 7
	Monitor and Control	115	13.7%	IS2002 .10
Architecture/ Network	Internet	296	35.4%	IS2002 .2 6
	General Knowledge of Arch./Network	177	21.1%	IS2002 .2 6
	Client/Server	147	17.6%	IS2002 .9
	Mainframe	129	15.4%	--------
	LAN/WAN Networking & N/W	104	12.4%	IS2002 .6
	Devices	33	3.9%	IS2002 .1 2 6
	Security			
Hardware	Server	255	30.5%	IS2002 .4 9
	General Knowledge of H/W	91	10.9%	IS2002 .4 9
	Desktop/PC	63	7.5%	IS2002 .4 9
	Devices/Printers/Storage	30	3.6%	IS2002 .4

Table 8. Mapping of IS 2002 Courses to Skill Requirements for Programmer/Analysts

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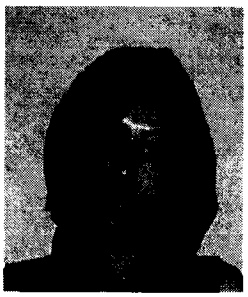

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