Critical Skills of IS Professionals:
Developing a Curriculum for the Future

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Abstract

A study was conducted to determine the expected skills and knowledge required for Information Systems professionals in three general staffing groups: programmers, analysts, and end-user support. A survey instrument was developed asking respondents to rate the importance of each knowledge/skill area three years from now for each of the staffing groups. The results show that Information Systems knowledge relating to the entire organization and overall business knowledge will be important with less emphasis being placed on specific Information Systems such as Decision Support Systems (DSS) and Executive Support Systems (ESS). More importance will be placed on web-based languages rather than more traditional languages such as COBOL. The so-called 'soft skills' such as teamwork, collaboration, writing and presentation delivery, and interpersonal and management skills will be critical for success in the Information Systems profession.

Keywords: curriculum development, information systems skills, information systems knowledge, programming skills, analyst skills, end-user support skills

1. INTRODUCTION

Revolutionary changes are occurring across the US and the world in information systems technology. Advances in information systems technology have changed the ways that information can be accessed and shared. These technological changes and the growth in availability of information have therefore been reflected in the need for well-educated IS professionals. Educators have the overwhelming responsibility of designing an IS curriculum that prepares future IS professionals for this dynamic field.

"The number of workers in the computer and software industries has almost tripled in the past decade." (Freeman and Aspray, 1999. p. 35.) However, this is not the only sector of American society in which information systems workers are employed. There are information workers in every sector of American society, in every geographic region of the country. Unfortunately, the demand for trained professionals exceeds qualified applicants.

The State of Illinois Citizens Agenda (1999) specifically calls for an increase in the number of graduates with skills and knowledge needed to meet new or emerging occupational demand. The Illinois Board of Higher Education (IBHE) Workforce Issues Paper

(1999) calls for the number of baccalaureate computer and information science graduates from public universities to be doubled by 2006. In the Governor's budget address, he has recommended full funding for the IBHE request including $8.9 million to increase the number of graduates in information technology, and $3 million to strengthen other programs where high demand for graduates exists. Currently, the US Congress is again considering extending the legislation to deliver more 6-year Visas to technology companies for foreign IS workers. In 1996, the IBHE program review of the information systems majors at our university recommended that the University consider reevaluating these programs in light of the documented shortage of information technology workers.

This set of circumstances created an atmosphere whereby a new curriculum in Information Systems could be developed within our unit. As is the case with considering change, considerable resistance existed within our unit to changing what was considered by some a stable and salable major. Some faculty members were content and some employers were satisfied particularly with the traditional programming curriculum currently offered.

The first step in designing our new curriculum was to review the literature that considered what the

expected workplace skills and knowledge will be for IS professionals. In a project which studied the impact of changes in the IS profession on the skills and knowledge requirements on future IS professionals, Lee, Trauth & Farwell (1995) report that the industry will demand IS professionals with not only technological skills, but also business operations, management, and interpersonal skills who can lead organizational IS activities. Lee, Trauth and Farwell project a more decentralized IS organization with an end-user-focused business orientation. They recommend that a generic curriculum meeting the needs of all future IS professionals is obsolete, and that different IS curricula must be developed to meet different IS careers.

Researchers have struggled with the issue of implementing models in various ways. Lightfoot (1999); Kim, Shim, and Yoon (1999) asked IS practitioners and educators to rate the importance of key IS issues. They recommended that educators and practitioners have a shared vision of key IS issues and collaborate on curriculum development. Srinivasan, Guan, and Wright (1999) describe a process of developing a new curriculum working with corporate partners. Maier, Clark, and Remington (1998) reviewed the content of job advertisements over a 15-year period to explore the changes in the MIS job market and found a growing diversity in the MIS job market. Hingorani and Sankar (1995) surveyed perceptions of graduates' skills and compared the results with skills required in industry.

In 1996, Maglitta, writing in Computerworld, reported that IS programs are struggling to keep up to date with the latest technologies and changes. Interviews with academicians and IS managers indicated new graduates lack the needed technical, business, industry, and soft skills needed in today's business world. Few graduates are trained in hot technologies such as telecommunications and relational databases - or even exposed to them. Even fewer are taught project management, communication, documentation, and team skills. Few still learn about specific industries or new areas such as electronic commerce and business process re-engineering. However, in a survey of IS programs in the USA, Gill & Hu (1998) report that the most popular programming languages were C/C++, SQL and COBOL, and that the dominant operating systems are Windows/OS2 and Unix. They suggested that there has been a transition from the centralized mainframe environment to the decentralized network based client-server architecture.

Other studies have stressed the impact of the Internet on IS skills and curricula, (Chaudhury & Rao, 1999), the importance of client/server technologies (Chaudhury & Rao, 1997; Alexander, 1997) and the importance of interpersonal and communications skills, (Young & Lee, 1997). Gonzenbach (1998) surveyed businesses and recommended placing the most emphasis on telecommunications, operating systems, systems analysis and design, networks and business communications.

The reported need for an increased supply of information systems workers is documented frequently; however, the identification of specific skills required for the variety of positions in IS is not as clear. While several model curricula exist, none of them could be easily applied to our individual program. Additionally, these "model" programs generally are "generic" as far as programming languages are concerned. Curricula changes require assessment of several factors including needs of business recruiting at the University, current curricula, resources, and faculty skills. None of these issues are addressed in existing curriculum models. Therefore, our curriculum had to be designed from the ground up considering the needs of employers and skills of current faculty. A study was conducted to determine the most critical areas of knowledge and skills for IS professionals within the next three years. In particular, these questions were addressed:

- What will be the important skills and knowledge required for future employees in Information Systems?
- What programming languages will be considered most important?
- Are there different levels of importance placed on skills and knowledge depending on job classification or staffing position?

2. RESEARCH METHODS

Based on extensive review of research, job announcements and advertisements, and IS literature, a questionnaire was developed. The questionnaire was fashioned after the research done by Lee, Trauth & Farwell (1999); it consisted of a compilation of IS knowledge, programming, platforms/operating systems/applications, networking and database software, business functional knowledge and interpersonal and management skills. Experts from three local industries were asked to complete the questionnaire and evaluate it for clarity and understanding. Based on the reviewers' feedback, the questionnaire was reformatted and revised. The revised questionnaire was mailed to the 380 companies who recruit at our University plus 100 additional companies from the Best 100 Places to Work in IT (Computerworld, 1999) After a three-week time period, a follow-up letter was mailed. Sixty-seven questionnaires were returned. Of those returned, 60 were usable giving a 13% response rate.

Respondents were asked to rate the importance of each skill area three years from now for each of three staffing groups. The staffing groups included programmers, analysts, and end-user support personnel. Programmers were defined as people doing software development and maintenance. Analysts were defined as people responsible for the planning, analysis, design and implementation of business applications. End-user support people were defined as IS staff providing computing support to users.

3. RESULTS

The results were analyzed using SPSS for the PC. ANOVA was used to determine if there were any differences in the importance of knowledge and skills among the three staffing areas. The Least Squared Difference test was used to determine where those differences were. Tables 1, 3, and 4 report the means for the IS knowledge areas for the three staffing groups. Table 2 reports the programming languages considered important for the programming staffing group.

Table 1
IS Knowledge Considered Important to the
Programmer Staffing Group—Three Years From Now

Knowledge Area	Mean	SD
Database modeling and development	4.33	.97
Software applications development and selection	4.29	.98
Structured programming/CASE tools	4.04	1.21
Electronic commerce	3.77	1.29
Information access and security	3.70	1.28
Systems analysis/structured analysis	3.70	1.00
Telecommunications/networks	3.57	1.29
Training/education	3.55	1.26
Decision support systems and group decision support	3.44	1.05
Information systems planning, management and evaluation	3.28	1.11
Knowledge management systems	3.20	1.2
End-user computing support	3.20	1.27

Table 2
Languages Considered Important to the
Programmer Staffing Group—Three Years From Now

Language	Mean	SD
SQL	4.16	1.14
Web-based languages (Perl, CGI, Java Script, HTML)	4.26	1.19
Java	4.13	1.16
Visual Basic	4.06	1.13
C++	3.76	1.30
C	3.25	1.33
COBOL	3.16	1.53

For the programming staffing group, broad-based IS skills such as database, software development, and structured programming/CASE tools appear to be most important in three years. New programming languages are expected to be more important than traditional languages such as COBOL.

Table 3
IS Knowledge Considered Important to the
Analyst Staffing Group—Three Years From Now

Knowledge Area	Mean	SD
Systems analysis/structured analysis	4.33	1.07
Information systems planning, management and evaluation	4.23	1.06
Software applications development and selection	4.13	.96
Database modeling and development	4.13	1.01
Electronic commerce	4.02	1.05
Information access and security	3.96	1.06
Telecommunications/networks	3.89	1.07
Training/education	3.80	1.05
Decision support systems and group decision support	3.66	1.18
Structured programming/CASE tools	3.59	1.06
Knowledge management systems	3.50	1.19

End-user computing support	3.38	1.09
Hardware acquisition (evaluation and selection)	3.36	1.21
Executive support systems	3.34	1.37
Help desk/information center	3.33	1.10

For the analyst staffing group, systems analysis, IS management, software applications development, and database modeling and development are considered to be most important. For the end-user staffing group, end-user computing support, helpdesk/information center, and training and education were considered most important.

Table 4
IS Knowledge Considered Important to the
End-User Staffing Group—Three Years From Now

Knowledge Area	Mean	SD
End-user computing support	4.80	.49
Help desk/information center	4.67	.62
Training/education	4.35	.88
Telecommunications/networks	3.81	1.01
Information access and security	3.68	1.11
Software applications development and selection	3.49	1.16
Electronic commerce	3.35	1.33
Decision support systems and group decision support	3.31	1.34
Executive support systems	3.18	1.37
Hardware acquisition (evaluation and selection)	3.16	1.40
Knowledge management systems	3.08	1.26
Information systems planning, management and evaluation	3.04	1.26
Systems analysis/structured analysis	3.00	1.32

Significant differences existed among staffing groups for the importance of business knowledge. Business Knowledge, which was defined by Knowledge of Business Functions, the Ability to Interpret Business Problems and Develop Appropriate Technical Solutions, the Ability to Understand the Business Environment, and Knowledge of the Specific Industry, were considered most important for the analyst staffing group. This generalization is supported by the level of important placed on the IS knowledge areas as shown in the tables. Overall, IS knowledge related to the organization is more important than knowledge of specialized information systems such as ESS or DSS.

Systems Analysis and Structured Analysis, IS Planning Management and Evaluation, Software Application Development and Selection, and Hardware Acquisition, were significantly more important for the analyst staffing group. However, Knowledge of Database Modeling and Development and Structured Programming/CASE Tools were significantly more important for the programmer staffing group. There were no differences among the groups for important of Knowledge of Information Access and Security; the means reveal that Information Access and Security was relatively important for all groups. There were also no differences among the staffing groups for Electronic Commerce and Telecommunications. An understanding of both of these skill areas was considered relatively important for all three staffing groups.

Significant differences existed among the staffing areas in specialized IS technical knowledge, such as DSS/GSS, Expert Systems, Knowledge Management, and ESS. In general, these knowledge areas were not considered to be as important for the end-user staffing group. The means reveal that Knowledge of Expert Systems was not considered important for any of the staffing groups. Understanding Knowledge Management Systems and Executive Support Systems were considered most important for the analyst staffing area. DSS/GSS was considered most important for the analyst and programming staffing groups.

Significant differences existed among the staffing areas in the Knowledge of End-User Support functions. Computing Support, Help Desk/Information Center, and Training/Education were considered most important for the end-user staffing area only.

Significant differences existed among the staffing areas in programming languages. Programming languages considered most important only for the programming staffing group included C++, SQL, C, Java and Web based languages (Perl, CGI, JavaScript, and HTML). Visual Basic and COBOL were considered most important for programmers and analysts. However, the means reveal that Visual Basic is considered more important than COBOL. COBOL was not considered particularly important to any of the staffing categories; however, it was considered more important to the programming staffing area than the other staffing areas. Visual Basic was considered an

important programming language for programmers and analysts, but not for the end-user staffing group.

Significant differences existed among the staffing areas in the so-called soft skills. The skill areas of Developing and Delivering Presentations, Managing Projects, and Writing Technical Documents were considered to be most important for the analyst staffing group, while Working Closely With Users and Clients was considered most important for the end-user staffing group. The Ability to Work Collaboratively in a Team Project Environment was considered to be important for all staffing groups, with no significant differences among groups. Particularly important to note, however, is the fact that none of the means for the "soft skills" were lower than 3.5 for any of the staffing areas.

No significant differences existed among the staffing groups for Knowledge of NT Networking Software or NT Server/Workstation Client. The means (all above 4.0) reveal that these were considered important for all three groups. The means reveal that the operating systems which were not considered as important to any of the three staffing areas included Linux, Apple, Novell, Sun, Unix, and AS400. The only operating system and software that were considered important to the end-user support and analyst staffing areas were Windows 95/98 and Windows NT. Windows 95/98 was considered most important for the end-user support area.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this study, the following conclusions and recommendations are suggested:

1. This research verifies the trend that IS jobs are becoming diversified and that a generic IS curriculum will not meet all the needs for all IS jobs. Curricula could be developed consisting of separate distinctive tracks that target the diverse job market. For example, networking, object oriented programming, ender-user systems, and legacy programming were developed for our new curriculum.
2. For students expecting to advance from programming jobs to systems analysts jobs, opportunities must be made available to prepare them for understanding the relationship of IS to the business organizational environment.
3. For programmers, database, structured programming and CASE tools will continue to be important, but less emphasis should be placed on specific IS systems such as DSS, ESS, Knowledge Management Systems, etc.
4. For programmers, more importance will be placed on web-based languages, (perl, JavaScript, and the like) SQL, and Java. A separate track could be developed for web-based languages. Students would then be allowed to choose the track which most interests them.

5. For the end-user staffing area, the importance of working with users and clients, training and education, and help desk and information center, Windows 95/98/NT are evident. A specific course that addresses these skills and other "soft skills" could be developed
6. The ability to work collaboratively, work with users and clients, and manage projects will continue to be an important skill for all IS staffing groups. These skills should be integrated into various IS course such as systems analysis and database.
7. Electronic commerce and telecommunications and information access and security issues need to be addressed for all IS staffing groups.
8. Programs should monitor enrollment data and placement data to continually improve program offerings.

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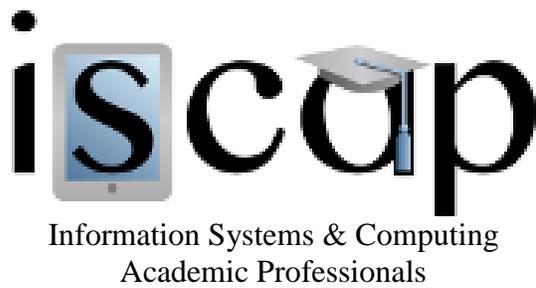
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