INFORMATION SYSTEMS ENTRY-LEVEL JOB SKILLS: A SURVEY OF EMPLOYERS

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ABSTRACT

This paper reports the results of a survey of employers who hire entry-level Information Systems (IS) graduates from a mid-sized private University and a small-liberal arts four-year college in Western Pennsylvania. The survey addresses the employer's perceptions of programming languages, certifications, various technical knowledge areas, and non-technical skills. Also addressed is the employer's views regarding new IS graduates' expected versus actual performance in the various technical and non-technical areas. The survey instrument used is identical to one used in a study done in the Midwest with a few modifications. Comparisons are made between the findings of the Midwest and Western Pennsylvania surveys.

Keywords: IS skills, IS employment, IT employment

1. INTRODUCTION

There is no question that the Information Systems field is in a state of flux. It is difficult for Information Systems faculty and collegiate curricula to keep current with the latest technology. Because most undergraduates are seeking specific skills needed to secure a job after graduation, higher educational institutions have responded by offering courses in "hot" topics in additional to those in the foundational basics of Information Systems. How to balance providing students with courses in the foundational basics of Information Systems, "hot" topics, and the core requirements for all undergraduates in a limited number of credits remains a struggle for any higher educational institution. The emphasis on the need for undergraduates to have more courses in the soft-skills, particularly in the last decade, has been an additional challenge to the undergraduate curriculum.

1.1 Curricular Models and Employer Needs May be Mismatched

Examination of many Information Systems/ Management Information Systems/ Computer Science (IS/MIS/CS) curricula in colleges and universities reveals a struggle of attempting to balance "training" and "education." The IS '97 Model Curriculum and the Curriculum Model of the Information Resources Management Association and the Data Administration Managers Association both view the undergraduate Information Systems curriculum as a mixture of communications and interpersonal skills, and, technical and problem solving skills. Both curricula stress the need for Information Systems graduates to have a wide variety of knowledge in technical, business, interpersonal skills and communication, team work, globalization, and legal, ethical, and social issues. These topics are not addressed as skills per se, but as general topics.

Employers are interested in a graduate's specific skills when looking to fill Information Technology (IT) positions. Recent literature supports this argument. Weldon (1998) found that in Virginia local employers were hiring graduates with a wide range of technology skills. The specific skills most in demand were anything Internet related, mainframe skills, experience with newer development tools and advanced programming skills. Barbian (2000) found that e-business and e-commerce were having an impact on IT. The skills required by IT professionals were changing in that not

only were technical skills required, but business operation skills as well. ComputerWorld (2000) publishes an annual survey of skills most wanted by IT employers and found that the skills most wanted for 2001 were web development skills in Java, language skills in Java, development tools in Microsoft Visual BASIC, and networking skills in TCP/IP. McGee (2001) reported that among the IT skills most in demand for 2001 were those "related to security, wireless, database, networking, and infrastructure technologies, as well as help-desk and other support talents" (p. 57). Also reported was that companies were seeking IT professionals with both solid technical expertise and business savvy. These types of individuals were needed to strengthen the existing IT environments as well as add Web-based capabilities to improve internal processes and customer service. Another high-demand skill reported by McGee is IT security. George and Colkin (2002) claim that universities are changing their course offerings to give graduates an edge in the competitive job market; that is, universities are offering classes in hot topics such as security, Java, .Net, Visual Basic, business, management, and communications.

Finding Information Systems (IS) graduates with needed skills is a problem for many businesses. Trauth et al. (1993) conducted a study to determine whether colleges and universities were responding fast enough to business and technology changes, and whether colleges and universities were providing the right type of education for future IS professionals. They concluded that the Information Systems profession was being pulled in opposite directions – toward a more business and human orientation, and toward those technical skills required to maintain the business' technology infrastructure. In another study, Lee et al. (1995) suggested that there is a misalignment between IS curricula in universities and business needs.

1.2 The Mismatch Addressed

McGee reported in 1998 that the mismatch between what the nation's computer-science and business schools teach and what IS managers state a job candidate needs is being addressed. According to McGee (1998) a number of executives at major IT suppliers and at user companies formed alliances with colleges, universities, training centers, and other educational organizations "to synchronize what's taught in the classroom with what is needed in the office" (p. 44).

Some of the efforts cited by McGee (1998) include: 1) Federal Express' list of recommendations for IT and business IS university curricula; 2) GM's CIO Szygenda acting in a advisory role to improve Information Systems, business and engineering education by working with several universities such as University of Texas Business School, University of Michigan Business School, American University, University of Alabama-Birmingham and University of Missouri; 3) Oracle's Academic Initiative Program; 4) United Health Corporation's partnership with Renssalaer Polytechnic Institute; and 5) Computer Associates open-ended funding program for the State University of New York at Stony Brook. Schenk and Pick (1998) found that there must be close ties between business and academia via partnerships. They viewed these partnerships as essential for survival and detailed four different university-corporate partnerships developed through Information Systems programs. In addition, Schenk and Pick (1998) presented a framework for describing potential partnership arrangements been academia and industry. Tobias (2001) reported on the efforts of several IT schools teaming with corporations to produce a better IT graduate. Also, he reported on companies that helped in the design of the curriculum at the University of Nebraska at Omaha's Peter Kiewit Institute. These companies continue to advise the program and provide student internships in their IT departments. Pennsylvania State University's IST (Information Sciences and Technology) program that began in Fall 1999 was developed with the help of managers from Fortune 100 companies, start-up companies, and non-profit organizations.

1.3 The Non-Technical Side

Most of the literature regarding IS curricula and employment of graduates has focused on the need for skills; that is, training, and not knowledge-based education. There are exceptions. McGee (1998) describes two companies who are not focused on the skills of their potential employees. Computer Task Group is reported to recruit graduates with degrees outside of IT and Computer Science. Cole, the company's Vice President of Education, stated "We're looking for people with that hungry look in their eyes... people who want to get the job done" (McGee, 1998, p. 52). Those individuals who are hired by Computer Task Group receive training in technical areas. Cambridge Technology Group, an Information Technology consulting and training firm, hires college graduates with degrees in liberal and fine arts. They especially like music majors. John Donovan, Cambridge Technology Group's chairman states, "We look for people who have a passion—whether it's for a musical instrument or a sport or programming. If you have an intense passion for something, you're more likely to be passionate for your work" (McGee, 1998, p. 52). Richards et al. (1998) and Young and Lee (1996) found that employers rate non-technical skills higher than technical skills since non-technical skills apply to every type of IS professional position.

1.4 Determination of Desired IS Skills

Review of the literature shows two major methods have been used to determine what skills are sought after by employers of IS undergraduates: 1) analysis of newspaper help wanted advertisements, and 2) survey research. The help wanted advertisement studies reinforce the dynamic nature of IS by illustrating the changing needs of industry over time.

Survey research has also been used to secure input about IS job skill requirements. Various parties have been surveyed: 1) employers (Cappel, 2001, 2002), 2) IS managers (Richards et al., 1998), 3) graduating seniors (Hingorani and Sankar, 1995), and 4) recruiters (Jiang et al., 1994; Young , 1996). Studies done in recent years by Trauth et al. (1993), Tang et al. (2000-2001), and Cappel (2001, 2002) have used survey questions to compare required versus achieved skill levels of performance. This technique is used to determine "gap analysis," i.e., gaps that exist between industry needs and academic preparation. Cappel specifically designed a survey to: "1) assess employer's perceptions of the importance of programming courses within the IS curriculum; 2) identify which programming languages are most important for IS majors, and 3) determine the importance of various technical and non-technical skills for entry-level IS positions…the technical and non-technical skills are assessed by comparing 'expected' to 'actual performance' " (pg. 76). Finally, Cappel's survey asked employers for advice about how students can better prepare themselves for the Information Systems profession prior to graduation. (Cappel, 2001, 2002)

The current study replicates Cappel's research with two differences. First, no questions were included on the survey that asked employer's advice regarding how students can better prepare themselves for the IS profession prior to graduation. Second, questions were added regarding the need for professional certifications. To achieve certification in a particular area usually requires successful completion of one or more examinations regarding very in-depth knowledge about that area. Rothke (2000) reported that professional certification is often a requirement for many information systems jobs even though many certifications do not require any type of real-world experience. He argued that certification is not an end in itself and when used and understood in context certifications do indeed offer value. Some colleges and universities, in the past few years, have begun to offer classes leading to professional certifications as a way to meet student's demand for specific technical knowledge. These classes are sometimes offered as part of a specialized track in the IS major, elective courses in the major, or as part of a continuing education program. Some certifications, such as the Microsoft Office User Specialist (MOUS) require very specific keyboarding and software knowledge skills. The emphasis is on the actual accomplishment of a given task via keystrokes. Others, like the Certified Netware Administrator (CNA) concentrate on very specific knowledge in a limited domain, but not specific skills needed to accomplish application and implementation of that knowledge. Professional certifications add to the struggle between "training" and "education."

2. METHODOLOGY

The survey employed in this study was designed using Cappel's result tables (Cappel, 2001, 2002). Part I consisted of questions regarding the responder's company characteristics. Part II questions profiled the responder. Part III consisted of questions related to programming languages and certifications. Part IV asked the responder to rate areas of technical expertise of a typical IS entry-level person. The responder was asked to rate the areas as to the level s/he **expected** the typical IS entry-level person to possess and the **actual** level that a typical entry-level IS person brings to the job. Respondents were not told the specific educational institutions who developed the survey. Part V asked the responder to rate areas of non-technical expertise of a typical IS entry-level person. The responder was asked to rate the areas just as s/he had done in Part IV – **expected** versus **actual**.

The survey was administered to two groups of the private University's doctorate of Information Systems and Communications program. Forty individuals comprise these two groups. Only 24 surveys were actually completed because the other individuals in the groups were not employers who hired entry-level IS individuals. Additionally, companies associated with the authors' undergraduate internship programs were targeted. Fifteen surveys were mailed in the Spring 2002 semester, six responses were returned. The companies associated with the authors' institution were also targeted for this study. A total of 30 responses were obtained, yielding a response rate of 51 percent.

3. RESULTS

3.1 Sample Characteristics

Table 1 shows the demographic characteristics of the respondents. The largest component of the sample (36.67%) indicated "Other" as their representative industry, followed by Manufacturing (26.67%). Respondents of the financial services/insurance industry (16.67%) were greater than those from computer/ computer services/IT consulting (13.33%) or healthcare/pharmaceuticals (6.67%). The aerospace/ defense, publishing/ printing, chemical /oil and gas, and utility industries are not represented. The size of the companies in terms of annual revenue was bimodal. The majority of the respondents (43.33%) stated that their company size was less than $100 million in annual sales. The majority of respondents also reported that they had a full-time IS staff of more than 150 (43.33%). The number of new hires for IS positions per year was reported by the majority of respondents as less than 5 (46.67%). Almost one-half of the respondents (46.67%) reported that their job title was "Other." Only 26.67% had the job title of IS Manager and 16.67% reported their job title as CIO. More than one-third of the participants reported that they had 13-18 years professional work experience and 26.67% reported more than 25 years of professional work experience.

3.2 Importance of Programming Languages

As in the Cappel 2000-2001 study, this survey contained two questions regarding the perceived importance of programming courses in the IS curriculum. The first question asked, " How many semesters of programming language should an IS major take?" Table 2 shows that the most frequently occurring value was 3 semesters. The mean response was 3.23 which is comparable to the mean of 3.27 found in Cappel's study.

As in the Cappel 2000-2001 study, these responses were weighted in reverse order; that is, the language ranked as first was given 3 points, second was given 2 points, and third was given 1 point. Table 3 shows that the two highest ranked programming languages were C++ and Java with a tie for third place between BASIC and COBOL.

In addition, participants were asked to rank the three most important programming languages from the following list: ABAP/4, BASIC, C, C++, COBOL, FORTRAN, HTML, Java, Perl, PL/1, PowerBuilder, Visual BASIC, and other. Twelve out of the 30 participants responded.

Cappel (2000-2001) found the following order (from highest): Visual BASIC, C++, Java, COBOL, and HTML. In both studies, C++ and Java were in the top three programming languages. However, BASIC was ranked third in this study and tied for eighth place in Cappel's study; while Visual BASIC was ranked sixth in this study and first in Cappel's study. These differences are most likely indicative of the regional differences in employers and industries between Cappel's survey and the current authors' survey.

Table 1 : Sample Characteristics of Responders

Industry		**New hires for IS positions / year**	
Computer/services/IT consulting	13.33%	Less than 5	46.67%
Healthcare, pharmaceuticals	6.67%	5-9	16.67%
Aerospace/defense	0.00%	10-19	3.33%
Manufacturing	26.67%	20-29	6.67%
Publishing, printing	0.00%	30-49	6.67%
Chemical, oil and gas	0.00%	More than 50	20.00%
Utilities	0.00%	**Job Title of Responder**	
Financial services, insurance	16.67%	CIO/VP, Information Systems/IS Director	16.67%
Other	36.67%	IS Manager/Consulting Manager	26.67%
Company size (in annual revenue)		Project Leader	3.33%
Less than $100 million	43.33%	Systems Analyst/Programmer, IS Consultant	0.00%
$100-499 million	20.00%	Human Resources Professional	6.67%
$500-999 million	0.00%	Other	46.67%
$1-3.9 billion	0.00%	**Responder's Professional Work Experience**	
$4-9.9 billion	13.33%	Less than 3 years	3.33%
$10 billion or more	20.00%	3-7 years	3.33%
Other	3.33%	8-12 years	20.00%
Full-Time IS professionals		13-18 years	36.67%
Less than 5	16.67%	19-24 years	10.00%
5-9	6.67%	25 or more years	26.67%
10-14	13.33%		
15-49	6.67%		
50-99	13.33%		
100-149	0.00%		
More than 150	43.33%		

Table 2: Perceived Importance of Programming Languages

Number of Semesters	
5	20.00%
4	20.00%
3	30.00%
2	23.33%
1	6.67%
0	0.00%

The results of both studies indicate that three semesters of a programming language is expected by IS employers. Many current collegiate IS curriculums do not require more than one semester of a programming language. Those that do clearly offer their students a competitive advantage in the marketplace. Both studies support the idea that programming languages remain a key foundational component of IS curricula and need to be emphasized more.

3.3 Certifications

The survey asked if certification in MOUS, A+, N+ or MSCE was important for an entry-level IS employee. Out of the 30 respondents, many did not rank the certifications. Table 4 shows the participant responses, including the number of participants who said "yes" - this certification is important and the number who said "no" – this certification is not important.

Overall, the majority of respondents indicated that certification in MOUS, A+, N+, or MSCE were not necessary. One participant commented on the questionnaire that they did not know what these certifications were. These results suggest that the area of certification may be new to some and/or not applicable to many IS entry-level job positions because of their very specific subject area.

3.4 Technical Knowledge Areas

Survey participants were asked to rate the importance of various technical and non-technical skills in the next two sections of the survey. The knowledge areas utilized paralleled those in Cappel's study and included the skills shown in Table 5. Participants were asked to rate each skill based on the level they "expected" a new IS graduate to have and then the "actual" level demonstrated by a typical entry-level IS employee. A five-point scale was provided with 5 as high and 1 as low. Table 5 shows the 19 technical areas, ordered by highest expected mean value. The differences between expected and actual levels were tested for statistical significance using paired t-tests.

The top eight highly rated technical skills were Systems Development Life Cycle (SDLC), Networking Concepts, Data Communication, Operating Systems, Procedural Programming Concepts, Object Oriented Programming Concepts, and Graphical User Interfaces with expected means greater that 3.3. The second group of skills were more moderately rated (with means between 2.8 and less than 3.3) and included: Systems Security, Decision Support Systems, Systems Requirements Gathering, Web Site Development, E-commerce, and Project Management. The lowest-rated items were Object Oriented Modeling, Enterprise Software and Computer Aided Software Engineering Tools.

Cappel's survey found six technical areas for the highly valued skills (with means above 3.3 for expected): Procedural Programming Concepts, SDLC, Systems Requirements Gathering, Process Modeling, Data Modeling, and Structured Query Language (SQL). The two surveys had only two areas in common for the highest rated skills: SDLC and Procedural Programming Concepts. The lowest-rated items were Object Oriented Modeling, Enterprise Software and Computer Aided Software Engineering Tools in both surveys.

Table 3 : Rank the Three Most Important Programming Languages

Rank/Language	Points	Rank/Language	Points
C++	52.5	C	2.5
Java	40	Perl	2.5
BASIC	22.5	FORTRAN	0
COBOL	22.5	PL/1	0
HTML	13	PowerBuilder	0
Visual BASIC	13	ABAP/4	0
		Other	0

Table 4: Are Certifications Important in These Areas?

	# Yes	Percent	# No
MOUS	3	15.0%	15
A+	8	40.0%	13
N+	1	5.0%	15
MSCE	8	40.0%	11

As indicated in Table 5, tests of significance show that the expected level was greater than the actual for every item. Also, for every item, the differences were statistically significant. Cappel found that tests of significance showed the expected level was greater than the actual level for every item except three: website development, graphical user interface design, and CASE tools. Only one skill in Cappel's study, website development, had an actual level higher than the expected level, but this difference was not statistically significant.

Table 6 shows the rankings of the current study and Cappel's study. The results of Cappel's study are consistent across the technical areas with procedural programming concepts, SDLC, and areas related to SDLC (systems requirements gathering techniques, processing modeling and data modeling) ranked at the top. The authors' current study results show inconsistency. SDLC is ranked number one, but process modeling and data modeling are number six and nine respectively. Data communications and hardware-related topics (e.g., operating systems) are ranked higher than system development and programming concepts for IS students.

Also inconsistent are the results of the certification section of the study compared to the ranking of the technical areas of networking concepts, data communications, and operating systems. These three areas are ranked numbers two, three, and four respectively. The A+ and N+ certifications deal specifically with these three specific technical areas, yet the majority of respondents indicated that certification in A+ or N+ was not necessary. As stated earlier, many participants did not respond to questions about certification. More than likely, some participants are not familiar with the certifications or are ignorant as to the specific content of the specific certification.

Table 5 : Technical Knowledge Areas

	Expected	Actual	Difference	P
Systems Development Life Cycle	3.52	2.31	1.21	0.000
Networking Concepts	3.52	2.38	1.14	0.000
Data Communication	3.48	2.59	0.90	0.000
Operating Systems	3.48	2.76	0.72	0.000
Procedural Programming Concepts	3.45	2.66	0.79	0.000
Process Modeling	3.41	2.52	0.90	0.000
Object Oriented Programming Concepts	3.39	2.57	0.82	0.000
Graphical User Interfaces	3.34	2.62	0.72	0.000
Data Modeling	3.31	2.17	1.14	0.000
Structured Query Language (SQL)	3.29	2.43	0.86	0.000
Systems Security	3.24	2.24	1.00	0.000
Decision Support Systems	3.17	2.10	1.07	0.000
Systems Requirements Gathering	3.14	2.18	0.96	0.000
Web Site Development	3.10	2.59	0.52	0.000
E-commerce	2.97	2.34	0.62	0.000
Project Management	2.86	1.93	0.93	0.000
Object Oriented Modeling	2.79	2.04	0.75	0.000
Enterprise Software (e.g., SAP, Peoplesoft)	2.52	1.70	0.81	0.000
Computer Aided Software Engineering Tools	2.52	1.81	0.70	0.000

Table 6: Comparison of Results From Two Surveys

Rank	Current Study (2002)	Cappel Study (2000-2001)
1	System Development Lifecycle	2
2	Networking concepts	16
3	Data communication	15
4	Operating systems	7
5	Procedural programming concepts	1
6	Process modeling	4
7	Object oriented programming concepts	8
8	Graphical User Interfaces	12
9	Data modeling	5

3.5 Non-Technical Knowledge Areas

The non-technical skills encompass a wide range of "soft skills" as shown in Table 7. The most desirable non-technical skill was professional ethics (4.34). Ten other skills were highly rated (with means above 4.0 for expected), including: Motivation to Work, Ability to Learn, Attention to Details, Time Management, Problem Solving, Maturity, Persistence, Teamwork, Initiative, and Oral Communications. The remaining characteristics were all rated above a 3.48 placing them above the third most desirable technical skill.

The expected level mean of nearly every non-technical skill receiving a rating of 3.50 is consistent with the findings of previous studies by Richards et al. (1998) and Young and Lee (1996). These studies found that employers rate non-technical skills higher than technical skills. Explanation for this fact is based on the idea that non-technical skills apply to every type of IS professional position. These skills would be expected to produce higher ratings and therefore higher means on a more consistent basis.

The mean difference for every non-technical skill was found to be statistically significant. Cappel also found the mean difference for non-technical skills to be statistically significant for every non-technical skill. The authors' study found that eleven non-technical skills had a mean difference of 1.00 or greater: Attention to Details, Time Management, Problem Solving, Maturity, Initiative, Oral Communications, Patience, Written Communications, Conflict Resolution, Ability to Apply IT to Business Problem, and Change Management. Oral and Written Communications were the two area with the greatest mean differences. Cappel only found that Attention to detail had a mean difference 1.00 or greater. Oral Communications and Problem Solving had the next highest mean differences followed by Written Communications.

Professional Ethics was the area that received the highest expected value in the authors' study. Ability to learn received the highest expected value in Cappel's work. This result may be explained by the events of September 11, 2001 and the Enron/Arthur Andersen accounting scandal that renewed our focus on ethics.

There is no doubt that soft skills are as important, if not more so than the technical skills in the IS curriculum. Individual and group classroom writings, group projects and presentations, internships, and involvement in student and professional organization can help in the student's development of these critical skills. These suggestions should not be limited to only IS curricula, rather they need to be part of the entire collegiate experience.

4. CONCLUSIONS

The results of the authors' survey, Cappel's survey, and the research done by others all support a number of ideas. First, the IS field is still dynamically changing. What's hot at any particular point in time does effect an employer's perception of the technical skill set needed by a potential employee. Therefore, IS academics must be in continual communication with the industry and a partnership between the two groups is essential. Comparing the two surveys suggests that the geographic location of the survey sample seems to play a part in the perception of desirable skills as well. One additional concern is the size of both samples. To make major, broad-reaching recommendations, a much larger and distributed survey should be undertaken.

Both surveys support that programming skills and SDLC remain key foundational components of IS with shifting focus on programming languages depending on both the geographic region and the industry. Secondly, non-technical skills are as important, if not more so than the technical skills. Professional ethics, oral and written communications, problem solving, and the ability to learn are important skills that cross the boundaries of all disciplines. These skills provide IS graduates with the ability to communicate with and work effectively with people in a wide variety of situations. As always, a delicate balance must be maintained to develop a strong educational foundation that produces graduates in Information Systems who have both employable skills as well as the ability to sustain a long career in a constantly changing field.

Table 7 : Non-Technical Skills

	Expected	Actual	Difference	P		Expected	Actual	Difference	P
Professional Ethics	4.34	3.41	0.93	0.000	Initiative	4.04	2.86	1.18	0.000
Motivation to Work	4.24	3.34	0.90	0.000	Oral Communications	4.00	2.76	1.24	0.000
Ability to Learn	4.24	3.45	0.79	0.000	Patience	3.97	2.97	1.00	0.000
Attention to Details	4.21	2.79	1.41	0.000	Written Communications	3.93	2.48	1.45	0.000
Time Management	4.14	2.93	1.21	0.000	Conflict Resolution	3.86	2.76	1.10	0.000
Problem Solving	4.14	2.93	1.21	0.000	Ability to Work Under Pressure	3.76	2.83	0.93	0.000
Maturity	4.14	3.10	1.03	0.000	Apply IT to Business Problems	3.69	2.55	1.14	0.000
Persistence	4.10	3.21	0.90	0.000	Change Management	3.62	2.38	1.24	0.000
Teamwork	4.10	3.31	0.79	0.000	Leadership	3.48	2.72	0.76	0.000

5. REFERENCES

Barbian, J. "IT in 2000 and Beyond," **Computer User**, 19:1, January, 2000, pp. 1 – 15.

Cappel James J. "Entry-level IS Job Skills: A Survey of Employers," **Journal of Computer Information Systems**, Winter 2001-2002, pp. 76- 82.

Curriculum Model of the Information Resource Management Association and the Data Administration Managers Association. www.irma-international-org, accessed May 20, 2002.

George, T. and E. Colkin. "Spring Cleaning for University Tech Offerings," **InformationWeek**, 885, April 22, 2002, pp. 88-90.

Goff, L. "Computerworld's 7th Annual Skills Survey: The Skills that Thrill," **ComputerWorld**, 34:49, December 4, 2000, pp. 54-59.

Hingorani, K. and C.S. Sankar. "Entry Level MIS Jobs: Industry Expectations Versus Academic Preparation," **Journal of Computer Information Systems**, Spring 1995, pp. 18-27.

IS '97 Model Curriculum and Guidelines for Undergraduate Programs in Information Systems (IS '97 Model Curriculum). www.is-97.org/rev/review1.asp, accessed May 20, 2002.

Jiang, J., I. Udeh, and A. Hayajneh. "Employers' Expectations of Incoming Graduates: From Recruiters' Views," **Journal of Computer Information Systems**, Spring 1994, pp. 57-59.

Lee, D., E. Trauth, and D. Farwell. "Critical Skills and Knowledge Requirements of IS Professionals: A Joint Academic/Industry Investigation," **MIS Quarterly**, 19:3, pp. 313-340.

McGee, M. "School Daze," **InformationWeek**, 667, February 2, 1998, pp. 44-52.

McGee, M. "Employers Get Choosy with Skills," **InformationWeek**, 857, October 1, 2001, pp. 57-60.

Richards, T. , R. Yellen, L. Kappelman, and S. Guynes. "Information Systems Manager's Perceptions of IS Job Skills," **Journal of Computer Information Systems**, Spring, 1998, pp. 53-57.

Rotheke, B. "The Professional Certification Predicament," **Computer Security Journal**, 16:4, Fall 2000, pp. 29-35.

Schenk, K.D., and J.B. Pick. "A Framework for Successful Partnerships Between Industry and Academia," **Journal of Computer Information Systems**, Fall, 1998, pp. 65-71.

Tobias, Z. "Making the Grade," **ComputerWorld,** 35:12, March 9, 2001, pp. 42-44.

Tang, H-L., S. Lee, and S. Koh. "Educational Gaps As Perceived by IS Educators: A Survey of Knowledge and Skill Requirements," **Journal of Computer Information Systems**, Winter 2000-2001, pp. 76-84.

Trauth, E., D. Farwell, and D. Lee. " The IS Expectation Gap: Industry Expectations Versus Academic Preparation," **MIS Quarterly**, 17:3, pp. 293-303.

Weldon, D. "Virginia is Hiring: Feast or Famine," **ComputerWorld**, 32:39, September 28, 1998, pp. 84-86.

Young, D. "The Relative Importance of Technical and Interpersonal Skills for New Information Systems Personnel," **Journal of Computer Information Systems**, Summer 1996, pp. 66-71.