The Evolving Undergraduate Information Systems Education: A Survey of U.S. Institutions

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ABSTRACT. To keep up with the fast-changing world of information technologies (IT), information systems (IS) education programs need to be assessed regularly in terms of curriculum and teaching methods. This article reports the results of a survey of 240 faculty members in its undergraduate programs representing 193 higher education institutions in the United States. Analyses of the data suggest that during the period 1991–1996 these programs have undergone dramatic changes to include coverage of the Internet, networking, and client/server-related topics. Meanwhile, traditional IS courses in such areas as mainframe operating systems, COBOL programming, and decision support systems have declined in importance. The information provided in this article should be valuable to IS educators and curriculum designers and could aid practitioners in their understanding of IS graduates. It also sheds some light on the future of IS education programs.

During the last 3 decades, information systems (IS) education has become a dynamic discipline, driven by dramatic developments in information technologies (IT) and the explosion in use of IT by organizations for both operational and strategic functions. Studies of the skills required by IS professionals (Athey & Plotnicki, 1991; Lee, Trauth, & Farwell, 1995; Leitheiser, 1992; Mackowiak, 1991; Trauth, Farwell, & Lee, 1993) have strongly emphasized the need for continual reassessment of IS education curricula. Failure to update courses to incorporate new technologies and new approaches to IS management can lead to programs that at best teach obsolete material and at worst instruct students in paradigms that are actually counterproductive in a world of globally distributed information and processing.

Recent studies of IS education have exhibited concern that IS curricula may be failing to keep up with the realities of corporate information systems (Lee, Trauth, & Farwell, 1995; Leidner & Jarvenpaa, 1995; Trauth, Farwell, & Lee, 1993). Unfortunately, our ability to judge the validity of these concerns is hampered by the absence of current research on existing IS programs. Certainly, descriptions of individual programs abound, as do a number of noteworthy efforts to measure the needs of the consumers of IS graduates (Lee, Trauth, & Farwell, 1995; Stolen, 1992). Absent from the literature, however, is an up-to-date description of what IS programs are teaching and how they are organized. The most recent effort in this direction appears to be a 1989 study of U.S. and Canadian undergraduate IS programs by Longenecker and Feinstein (1991). Given the changes in information technologies since that time, a comprehensive and up-to-date description of undergraduate IS curricula is urgently needed.

In this article, we present the results of a survey of IS faculty in the United States. It is intended to serve as a useful frame of reference for IS academics who are considering redesign of their own programs, and for IS practitioners who are involved in the curriculum design process at their local academic institution or who are grappling with the question of whether or not to hire graduates of IS programs. Although data on both undergraduate and graduate programs were gathered, in the present paper we focus strictly on data related to undergraduate IS programs.

Method

Survey Questionnaire

The survey questionnaire was developed with the immediate objective of advancing knowledge about IS education in the United States. It was also intended to provide information about existing IS programs for a biannual reassessment of the undergraduate computer information systems major being conducted at our university. The questions in the survey were designed to address a number of questions, including

1. How is the IS discipline incorporated into the organization of institu-

tions having one or more IS faculty members?

2. What are the characteristics of faculty who teach IS programs?

3. What types of IS programs are being offered at the undergraduate level, and how has their content changed in response to evolving technology over the last 5 years?

The original form of the questionnaire had eight sections and consisted of more than 120 questions ranging from individual and institutional profiles to the actual content of individual IS programs. All questions fell into two categories: multiple-choice questions and anchored multipoint scale questions. Before the survey was mailed out, it was pretested on the faculty members at our institution. The pretest yielded a unanimous conclusion that the instrument was too long. Therefore, approximately 25% of the questions in the original survey were eliminated. Because we felt that further cutting would have required removing questions of considerable interest, we decided to accept the reduced response rates to be expected with such a complex instrument in order to acquire a richer picture from those who did respond. At the end, the instrument consisted of eight sections regarding various aspects of the IS programs, with a total of 90 questions.[1]

Participants

The survey instrument was mailed to IS faculty members in the United States, who were listed in the Management Information Systems Research Center (MISRC) directory (DeGross, Davis, & Kuehl, 1995) in late October 1996. Responses were accepted through 15 January 1997. Of 2,056 survey instruments mailed out, representing 442 different higher educational institutions in the United States, 240 usable responses were returned, a 12% individual response rate. Viewed in terms of institutions, the rate was much higher: Surveys were returned from faculty at 193 different institutions, a 44% response rate. Thus, even though the individual response rate was low, the institutional coverage appeared to be satisfactory.

Responses were received from several different types of academic institutions, as shown in Table 1. Most of the respondents were affiliated with traditional 4-year colleges and universities with advanced degree programs: About 84% of the responding institutions offered graduate level programs, with 46% of them offering doctoral level degrees and 38% offering master's level degrees. Nearly all the institutions had a business school that functioned either as an autonomous (82%) or semiautonomous (12%) unit. A number of different institutional affiliations were also present in the survey population, with public institutions (72%) and private institutions (25%) predominating.

In Tables 2 and 3, we present information about the responding faculty. Of those, 75% were male, 25% were female (excluding 3% who did not reply to the question), about 69% were

TABLE 1. Characteristics of the Responding Institutions

	Institutions		Respondents	
Type	No.	%	No.	%
4YwD	89	46.11	117	48.75
4YwM	74	38.34	90	37.50
4YwU	22	11.40	25	10.42
Other	8	4.15	8	3.33
All	193	100	240	100

Note. 4YwD, 4YwM, 4YwU represent 4-year colleges/universities with highest degree offered being doctoral, master's, and bachelor's, respectively. All of these institutions offer at least one type of IS program to undergraduate students, including IS major, IS minor, and IS survey.

TABLE 2. Characteristics of the Responding Faculty

	Tenure						Degree			
	Tenured		Tenure-earning		Nontenure		Terminal		Nonterminal	
Institution	No.	%	No.	%	No.	%	No.	%	No.	%
4YwD	81	69.23	24	20.51	10	8.55	108	92.31	7	5.98
4YwM	65	72.22	17	18.89	7	7.78	82	91.11	7	7.78
4YwU	14	56.00	9	36.00	2	8.00	19	76.00	4	16.00
Other	4	50.00	1	12.50	3	37.50	7	87.50	1	12.50
All	164	68.33	51	21.25	22	9.17	216	90.00	19	7.92

Note. Percentages are computed within institution types, except the category for all institutions.

TABLE 3. Rank Distribution of Responding Faculty

	Academic rank									
	Professor		Associate professor		Assistant professor		Instructor		Adjunct	
Institution	No.	%	No.	%	No.	%	No.	%	No.	%
4YwD	34	29.06	46	39.32	26	22.22	6	5.13	0	0.00
4YwM	43	47.78	25	27.78	17	18.89	1	1.11	3	3.33
4YwU	7	28.00	7	28.00	9	36.00	1	4.00	1	4.00
Other	6	75.00	0	0.00	1	12.50	0	0.00	1	12.50
Overall	90	37.50	78	32.50	53	22.08	8	3.33	5	2.08

Note. Percentages are computed within institution types, except the category for all institutions.

tenured, 21% were in tenure earning positions, and 9% were in nontenure positions. The 4-year institutions granting master's degrees had the highest percentage of professors (48%), the institutions granting doctorates had the highest percentage of associate professors (39%), and the undergraduate-only institutions had the highest percentage of assistant professors (36%). The percentages for instructors and adjuncts are not comparable because of smaller sample sizes. Ninety percent of the faculty held a doctoral degree. Of these degrees, about 40% were in the MIS area and 54% in MIS, management, and accounting combined. These percentages of IS-related degrees are significantly higher than the 30% terminal degree ratio reported by Longenecker and Feinstein (1991) in a 1989 survey. This increase in IS-related terminal degrees, coupled with the fact that over two thirds of IS faculty have tenure, suggests that IS has matured considerably over the last decade as an academic discipline.

Results

IS Programs

The survey data show a wide variety of courses and programs offered by the institutions surveyed. The majority (78%) offered an undergraduate IS major, with fewer offering an undergraduate IS minor (55%) and IS survey courses to all students (65%). The breakdown by institution types is presented in Table 4. It can be seen that IS major programs are offered more often in institutions with doctoral programs (82%) then those with lower level degree programs.

Credit Requirement

About half of the undergraduate programs had fewer than 50 graduates each year. The majority of the programs (59%) required 22 or more semester hours (or equivalent) of IS courses. The breakdown for number of graduating majors and IS course requirement is provided in Figure 1. Assuming a fairly typical 3 credit hours per course, this translates into about eight or more information systems courses required for IS undergraduate majors at institutions using a semester system.

Technical Skills Taught

A particularly important objective of this IS faculty survey was to assess the IS undergraduate program content. Three sections of the survey were used to assess technical and computer language skills being taught, the computer hardware platforms and operating systems in use, and the IS content areas incorporated in 1996, as compared with those of 5 years earlier.

As can be seen from Table 5, a wide range of third- and fourth-generation languages were being taught in under-

TABLE 4. Characteristics of the Undergraduate IS Programs

	Undergraduate program offered					
	IS major		IS minor		IS survey	
Institution	No.	%	No.	%	No.	%
4YwD	73	82.02	46	51.69	63	70.79
4YwM	59	79.73	44	59.46	47	63.51
4YwU	17	77.27	14	63.64	12	54.55
Other	2	25.00	2	25.00	4	50.00
Overall	151	78.24	106	54.92	126	65.28

FIGURE 1. Characteristics of Graduating Classes and Requirements

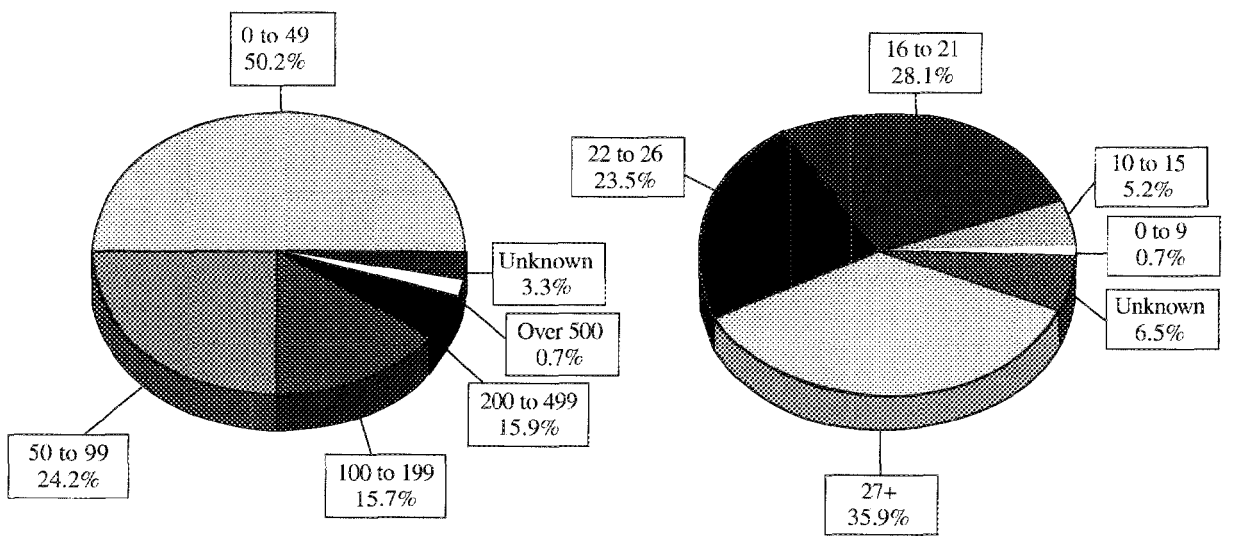

TABLE 5. Programming Language Taught in Undergraduate IS Programs

	Institutions (N = 124)									
	4YwD (n = 57)		4YwM (n = 50)		4YwU (n = 14)		Other (n = 3)		All (n = 124)	
Language	No.	%	No.	%	No.	%	No.	%	No.	%
COBOL	44	77.19	40	80.00	8	57.14	2	66.67	94	75.81
C++	44	77.19	30	60.00	12	85.71	2	66.67	88	70.97
SQL	40	70.18	26	52.00	11	78.57	1	33.33	78	62.90
C	30	52.63	23	46.00	5	35.71	2	66.67	60	48.39
Basic/Visual Basic	28	49.12	15	30.00	5	35.71	1	33.33	49	39.52
Other	18	31.58	14	28.00	4	28.57	1	33.33	37	29.84
dBASE/xBase	11	19.30	12	24.00	2	14.29	0	0.00	25	20.16
Pascal	11	19.30	8	16.00	1	7.14	1	33.33	21	16.94
RPG	6	8.77	4	12.00	1	7.14	0	0.00	12	9.68
Assembler	5	10.53	6	8.00	0	0.00	0	0.00	10	8.06
FORTRAN	4	7.02	5	10.00	0	0.00	0	0.00	9	7.26
PL/1	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00

Note. Percentages are based on the number of institutions indicating that they taught one of these languages in undergraduate IS programs (numerator) and the number of institutions that responded to this question for Table 5 (denominator). The total number of institutions that responded to this question was 124, which is smaller than the total number represented in the survey (193).

TABLE 6. Operating Systems and Platform Used in Undergraduate IS Programs

	Institutions (N = 125)									
	4YwD (n = 57)		4YwM (n = 51)		4YwU (n = 14)		Other (n = 3)		All (n = 125)	
OS/platforms	No.	% of all	No.	% of all	No.	% of all	No.	% of all	No.	% of all
Windows/OS/2	55	96.49	46	90.20	13	92.86	3	100.00	117	93.60
UNIX	39	68.42	22	43.14	6	42.86	1	33.33	68	54.40
DOS	27	47.37	22	43.14	6	42.86	1	33.33	56	44.80
Mainframe	29	50.88	19	37.25	4	28.57	1	33.33	53	42.40
Macintosh	8	14.04	8	15.69	2	14.29	1	33.33	19	15.20
Other	6	10.53	11	21.57	1	7.14	0	0.00	18	14.40
AS 400	4	7.02	2	3.92	0	0.00	0	0.00	6	4.80

Note. Percentages are based on the number of institutions indicating that they used such an operating system in undergraduate IS programs (numerator) and the number of institutions that responded to this question for Table 6 (denominator). The total number of institutions that responded to this question was 125, which is smaller than the total number represented in the survey (193).

TABLE 7. The Anchored Scales for IS Program Content

Scale value	Description
0	Not taught in any course
1	Minor topic in one or more elective courses
2	Major topic in elective courses or minor topic in required courses
3	Central topic in an elective course or major topic in a required course
4	More than one: Central topic of elective, major topic of required course
5	Central topic of a required course and/or several elective courses
6	Central topic of more than one required course

graduate IS programs in 1996. Overall, the three most popular were COBOL (taught in 76% of all institutions), C++ (71%), and SQL (63%). C was not far behind, in fourth place (48%). When C and C++ are combined, they become the second most popular, with 73% of the responding institutions teaching them. This order generally held across all institutions with one exception: C++ replaced COBOL in the first place at four-year undergraduate-only institutions. The numbers for the "other" category may not be comparable because of smaller sample size.

The popularity of these top three languages is no coincidence; it reflects the needs of the IS job market. A study by Mackowiak (1991) found that among all the ads requiring programming languages in the *Washington Post High Tech Careers* spring and fall 1989 issues, the two most frequently required languages were C (39.2%) and COBOL (20.6%). Among the ads for special-purpose languages, the two most frequently required were CICS (33.3%) and SQL (18.5%).

Comparison of the data in Table 5 with the findings of a 1989 survey of AACSB-accredited business schools by Chen, Danesh, and Willhardt (1991) offers an interesting perspective on how things have changed. Among the surveyed business schools offering CIS programs, the top three languages taught were (a) under the ACM curriculum, COBOL (45%), Pascal (18%), and Basic (13%); and (b) under the DPMA curriculum, Basic (46%), COBOL (26%), and Pascal (14%). Though COBOL still remains the most popular language taught in IS programs today, the teaching of Basic and Pascal has dropped significantly. C++ and SQL have shown the most significant rise: They were not even on the list of both ACM and DPMA curricula for CIS programs in 1989. This is perhaps the result of the widespread use of Windows and relational database applications over the last decade. The continued strong showing of COBOL language may be attributed to two major factors: the large installed base of mainframe shops with mostly COBOL applications and the year 2000 problem, which has created a surge in demand for skilled COBOL programmers.

As in the case of programming languages, a large number of different operating systems and platforms are used in undergraduate IS programs. However, there was a clear operating systems leader (see Table 6): Windows- or OS/2-based systems were used in 94% of all institutions. UNIX came in at a distant second place (54%), closely followed by DOS (45%) and mainframe operating systems (42%). Though the leadership of Windows or OS/2 systems is no surprise, the strong showing of UNIX, traditionally the preferred operating system of the computer science and engineering field, suggests that many undergraduate IS programs are teaching technical skills related to complex and large-scale computer systems.

Changes in Program Content

To assess the content of IS undergraduate programs, we developed 40 questions, mostly based on the technical-specialties knowledge measures devised by Lee, Trauth, & Farwell (1995). In addition, a number of content questions relating to areas of specific current interest—both technical and nontechnical—were added (e.g., the Internet, client-server applications development, ethical issues in IS, as well as a number of categories of case studies).

To improve reliability and validity of these measures, the original 5-point scale was changed to a 7-point anchored scale in which detailed descriptions for each value were provided (see Table 7). Respondents were asked to rate the emphasis of their undergraduate IS programs for the 40 content areas both in 1996 and 1991, according to this scale. Based on the responses, the current 10 most and least important content areas for 1996 were compared with those for 1991, as shown in Tables 8 and 9. The 10 areas experiencing the greatest upward and downward movement are listed in Tables 10 and 11.

The changes show an unmistakable transition from traditional text-based, centralized, and mainframe-dominated architectures to distributed, client/server computing in a graphical environment. Databases and systems analysis/design remain the mainstays of IS undergradu-

TABLE 8. The Top 10 Contents of Undergraduate IS Program: 1996 and 1991

Rank	1996	1991
1	Relational database	COBOL programming
2	Systems analysis/structured analysis	Systems analysis/structured analysis
3	Data management (e.g., data modeling)	Programming in at least one 3GL
4	Telecommunications	Relational database
5	Networks	Data management (e.g., data modeling)
6	Internet technologies and usage	End-user application development (e.g., spreadsheets, DBMS)
7	Client/server application development	Systems lifecycle management
8	End-user application development (e.g., spreadsheets, DBMS)	Case studies of IS situations, emphasizing systems implementation issues
9	Programming in at least one 3GL	Decision support systems
10	Case studies of IS situations, emphasizing systems implementation issues	Structured programming/CASE methods and tools

TABLE 9. The Bottom 10 Contents of Undergraduate IS Programs: 1996 and 1991

Rank	1996	1991
31	Ethical issues in IS	MS-Windows applications development
32	Group support software (e.g., GDSS, Lotus Notes)	Organizational and human resource impact of IT
33	Expert systems/artificial intelligence	Ethical issues in IS
34	Organizational and human resource impact of IT	Case studies of IS situations, emphasizing ethical issues
35	Case studies of IS situations, emphasizing OB/HRM issues	Case studies of IS situations, emphasizing marketing issues
36	Case studies of IS situations, emphasizing marketing issues	Group support software (e.g., GDSS, Lotus Notes)
37	Marketing using IT	Minicomputer operating systems
38	Minicomputer operating systems	Internet technologies and usage
39	Mainframe operating systems	Case studies of IS situations, emphasizing OB/HRM issues
40	Assembly language	Marketing using IT

TABLE 10. The Top 10 Contents With the Greatest Upward Change From 1991 to 1996

Rank	Program area	Current rank	Previous rank	Change
1	Internet technologies and usage	6	38	+32
2	Networks	5	25	+20
3	Client/server application development	7	24	+17
4	MS-Windows application development	15	31	+16
5	Distributed processing	18	29	+11
6	Fourth-generation languages	17	27	+10
7	Case studies of IS situations, emphasizing emerging technologies	13	22	+9
8	Telecommunications	4	12	+8
9	Emerging information technologies	14	21	+7
10	Case studies of IS situations, emphasizing ethical issues	29	34	+5

TABLE 11. The Top 10 Contents With the Greatest Downward Change From 1991 to 1996

Rank	Program area	Current rank	Previous rank	Change
1	Mainframe operating systems	39	13	–26
2	COBOL programming	26	1	–25
3	Computer hardware	28	11	–17
4	Decision support systems	23	9	–14
5	Expert systems/artificial intelligence	33	19	–14
6	Assembly language	40	30	–10
7	Case studies of IS situations, emphasizing project management	24	16	–8
8	Microcomputer operating systems	27	20	–7
9	Managing the information resource	20	14	–6
10	Programming in a least one 3GL	20	14	–6

ate programs. But to make room for new material, the emphasis on teaching 3GLs, particularly

COBOL programming, has declined. The Internet, data communications, and client/server related concepts show the greatest upward movement, whereas the mainframe operating systems, COBOL programming, and computer hardware show the greatest downward movement. These changes appear to be in line with the trends in real-world information technologies.

Conclusions

Based on the responses of the IS faculty members from close to half of the higher education institutions that offer undergraduate IS programs in the United States, we have examined two of the most important aspects of the IS undergraduate curriculum: the technical skills being taught in the undergraduate programs, and the changes in the content of the curriculum over a period of 5 years that witnessed explosive growth in information technology. A number of interesting findings are suggested by our data.

The first, and perhaps the most important, finding is a major transformation in the undergraduate IS programs: The Internet and client/server-related areas have become prominent, while mainframe operating systems, COBOL programming, and computer hardware have declined in importance. This finding has two implications. First, it shows that IS programs are dynamic and vigilant, constantly adapting themselves to the changing environment of real-world information technologies. Second, it shows the need for IS faculty members to update themselves continually to stay current in both teaching and research. A faculty member with a solid mainframe background would be rendered virtually useless if he or she had not updated his or her skills over these 5 years.

The second finding is that despite the rapid rise of C/C++ and SQL, COBOL is still the king of programming languages taught to undergraduate students. We take this to be a reflection of its historical importance as the dominant business language in most mainframe systems, and a recent resurgence in demand for COBOL programmers as a result of the millennium date (Y2K) problem. As the latter factor inexorably works itself out over the next 3 years, we would anticipate an acceleration of the already rapid decline in COBOL content. The rise to prominence of C/C++ and SQL can be attributed to the proliferation of Windows- and database-related applications in business and organizations over the last decade. Thus, we highly recommend that IS programs constantly monitor the change of the real-world information technologies and adjust their programming courses accordingly to equip students with the most desirable skills in the highly competitive global market.

We also found that the undergraduate IS programs seem to have matured in the past decade. The majority of the IS faculty members currently have tenure, and over 90% hold terminal degrees, mainly in MIS or business-related disciplines. Given the dynamic nature of the IS discipline, this maturity poses an interesting challenge to all IS programs: In order to offer the latest technological skills to students, either the existing faculty members have to keep updating their skill set, or the programs have to keep hiring new faculty members. The recent boom in the academic job market for new doctoral candidates in the IS field partially reflects this reality.

It is fair to conclude that undergraduate IS programs are highly dynamic and diverse in content covered and emphasized. In fact, the average standard deviations for all 40 content measures were about 44% and 46% of the mean values for 1996 and for 1991, respectively, demonstrating the diverse nature of the undergraduate IS programs. Though such diversity may be desirable given the variability of local IT environments, it also presents major challenges to faculty and business alike. It is clear that there is no such thing as a "typical" undergraduate IS program, making the process of evaluating IS curricula and IS graduates far more difficult. This article represents a step toward better understanding and characterization of the range of undergraduate IS programs. It should serve to facilitate future discussions and investigations into IS education.

NOTE

1. The survey questionnaire is available from the authors upon request.

REFERENCES

Athey, S., & Plotnicki, J. (1991). A comparison of information systems job requirements in major metropolitan areas. *Interface: The Computer Education Quarterly, 13*(4), 47–53.

Chen, J., Danesh, N. A., & Willhardt, J. A. (1991). Computer curricula in AACSB-accredited business schools. *Interface: The Computer Education Quarterly, 13*(4), 60–72.

Lee, D. M. S., Trauth, E. M., & Farwell, D. (1995). Critical skills and knowledge requirements of IS professionals: A joint academic/industry investigation. *MIS Quarterly, 19*(3), 313–340.

Leidner, D. E., & Jarvenpaa, S. L. (1995). The use of information technology to enhance management school education: A theoretical view. *MIS Quarterly, 19*(3), 265–291.

Leitheiser, R. (1992). MIS skills for the 1990s: A Survey of MIS managers' perceptions. *Journal of Management Information Systems*, Summer, pp. 69–91.

Longenecker, H. E., & Feinstein, D. L. (1991). A

comprehensive survey of USA and Canadian undergraduate programs in information systems. *Journal of Information Systems Education, 3*(1), 8–13.
Mackowiak, K. (1991). Skills required and jobs available for CIS Majors. *Interface: The Computer Education Quarterly, 3*(4), 9–14.
Stolen, J. (1992). The undergraduate MIS curriculum: A sampling of AACSB schools. *Journal of Computer Information Systems*, Winter, pp. 174–186.
Trauth, E., Farwell D., & Lee, D. (1993). The IS expectation gap: Industry expectation versus academic preparation. *MIS Quarterly, 17*(3), 293–303.