Systems Analysis & Design: Student Perception Versus Employer Needs

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ABSTRACT

In this study, we examine student's perceptions of key elements of the systems analysis and design discipline and compare those perceptions to employer's perceptions and note areas of consistency as well as inconsistency. Research in this area is crucial because students will be much more effective in preparing for careers that relate to the systems analysis and design area if they have an understanding of what is most important in the marketplace. Finally, if academicians can "sell" the key elements of the systems analysis and design area to students, such students will likely be more motivated in learning about the key elements.

INTRODUCTION

Many management information systems (MIS) professors are concerned with student expectations with regards to their understanding of the systems analyst role in an organization. Professors frequently ask themselves "are we preparing our students correctly for the current job market?" In this study, we examine such questions and attempt to shed some light on employers' and students' expectations.

According to the occupational outlook handbook of the U.S. Department of Labor, Bureau of Labor Statistics (U.S. Department of Labor, 2004), there were 468,000 computer systems analysts employed in 2002 with median annuals earnings of $62,890. Computer systems analysts, together with database administrators and computer scientists, are expected to be among the fastest growing occupations through 2012, with a predicted growth of over 36% on average (U.S. Department of Labor, 2004). With a median starting salary of $40,556 for graduates with a bachelor's degree in MIS, this is an attractive job market. This fast-growing job market comes despite the dot com bust and projections continue to be rosy for future growth in the MIS arena.

Because this is such a high growth area and because such a modest amount of research has been focused in the area of Systems Analysis and Design (SAD) for students desiring to be systems analysts, we examine the following questions in our study:

- Do our students know what to expect when they take a job as systems analyst?
- Are we preparing our students as well as possible for this job market?

In our effort to answer these general questions, we investigate the following more specific questions:

- What do students think about the importance of the topics taught in Systems Analysis and Design (SAD) classes?
- What do employers think about the importance of these same topics?
- Are there differences between students' and employers' rankings regarding the importance levels of these topics?
- How do other factors (like work experience, GPA, gender) influence the students' ranking regarding the importance levels of these topics?

The remainder of the paper is structured as follows: First, a literature review of studies that explore the course content of SAD classes and studies that look at the job market for MIS majors is offered. Then we describe describes the research methodology used, followed by the results and discussion of the results in the next sections. Finally, a summary of the findings, implications for educators and future research areas are discussed.

LITERATURE REVIEW

This section summarizes the empirical findings of studies about content of the SAD classes and studies that look at the job market for MIS graduates.

Course Content Of SAD Classes

There is a wide variety of studies that deal with certain aspects of teaching SAD courses. Fox (2002) found that the inclusion of a real-world project benefits the students by improving their team work and project management skills as well as their communication skills with teammates, clients and the instructor. The inclusion of Service-Learning Projects in information systems courses was the focus of a study by Hoxmeier and Lenk (2003). They found that service-learning projects improved understanding in both technical skills needed for SAD and soft skills, especially communication and project management skills. In addition, the projects helped to develop the role of the university in the community. Cappel (2001) developed an extensive teaching case that can be used effectively as a class project to teach SAD skills. The case can be addressed as a team so that students can acquire soft skills, like teamwork and communication skills, in addition to the technical skills. Myers (2003) also developed a case that can be used as a capstone project in a team environment. The case is designed to illustrate multiple cycles through the development process, in addition to SAD key concepts. Another special feature of Myer's case is the use of a special email address that allows students to communicate with the (fictional) client.

Studies about the overall topics/concepts of teaching SAD are limited. Educators can get advice by examining the model curriculum developed jointly by the Association for Computing Machinery (ACM), Association of Information Systems (AIS) and Association of Information Technology Professionals (AITP) (2002) but the model curriculum only shows what topics should be taught. It does not give advice on which subject matters to emphasize or go into detail how best to teach them.

Tastle and Russel (2003) surveyed IS educators about the perceived importance of SAD topics. The survey consisted of three parts: (1) the amount of time spent on each topic, (2) the perceived importance of each topic in a traditional structured analysis course and (3) the perceived importance of each topic in an object-oriented analysis course. For "amount of time spent on each topic" the researcher found that topics could be grouped into three categories:

- Topics that are generally avoided by IS instructors, which are state-transition diagramming, file and database design, sequence diagramming, normalization, class diagramming, and Unified Modeling Language (UML);
- Topics that are generally included by IS instructors, which are system design concepts in general, overview of systems analysis, process modeling in general, project management concepts, data modeling in general, and structured analysis;
- Topics that cannot be placed in either group, which are project initiation and data collection analysis, entity relationship diagramming, data flow diagramming, cost-benefit and payback analysis, decomposition diagramming, interface design, use case, program designs, and systems methodologies.

One exception was object-oriented analysis (OOA), which did not fit in any category because of its high entropy: whereas some IS educator perceived this topic as definitely important, other educators did not spend any time at all on this topic. Tastle and Russel (2003) concluded that the OOA methods were not yet mainstream and that as the discipline matures, the level of agreement on what is important will increase. Conversely, Athey and Plotnicki (1998) found that object-oriented technology skills were one of the emerging "hot" skills in 1996. Their advice was to include object-oriented design skills as an important component of a SAD course. Therefore, whereas the Tastle and Russel (21) study showed that object-oriented design was not yet included in all SAD curricula, it was taught in all the classes

surveyed for this research. All topics identified in the Tastle and Russel study were included in the survey instrument of our study.

Skills Needed For The Job Market

The majority of studies analyzed included the overall job market for IS graduates, not specifically the job market for system analysts. Athey and Plotnicki (1998) evaluated job opportunities for IT professionals by analyzing newspaper help wanted advertisements from ten different cities over ten years. They specifically looked at emerging and dying skills to provide guidance for curriculum development, especially programming languages, database skills, infrastructure skills and networking skills.

Studies that looked at importance of technical versus soft skills are inconclusive about which skills are more desirable. On the one hand, studies that looked at newspaper help wanted advertisements emphasized technical skills (Athey and Plotnicki 1998, Litecky, et. al. 1995, Lithecky et.al. 2004, Prabhakar et. al. 1995, Trower 1993). On the other hand, when surveys were used for data gathering, the results depended on the surveyed subject demographics. Leitheiser's (1992) survey of information systems (IS) managers ranked interpersonal communication skills as most important. Other surveys by Byrd and Turner (2004), Green (1989) and Lau et al. (1997) showed that chief information officers and end users ranked technical skill as most important in affecting IS success. The two studies of Green (1989) and Wade and Parent (2001), describing how systems analysts perceive the importance of various skills are also inconclusive. Whereas the one study by Wade and Parent (2001) found that analysts perceive organizational skill as most important, the other study by Green (1989) found that behavioral skills, such as diplomacy, sales and politics are most important. A good overview of studies dealing with the paradox of soft skills versus technical skills in hiring can be found in Litecky et al. (1996). In this paper they also propose a two-stage model of IS recruiting derived from image theory to resolve this paradox. According their theory, technical skills are often used in the first stage of the potential employee interview process as filters whereas soft skills are used in the second, choice stage.

RESEARCH METHODOLOGY

To answer the first question, whether students know what to expect when they take a job as a systems analyst, we examined several of the more popular current textbooks (Dennis et. al. 2005, Hoffer et. al. 2002, Whitten et. al. 2004) and identified topics usually taught in SAD classes. We also surveyed students currently enrolled in SAD classes to understand students' perceived importance of SAD topics. To answer the second question, whether we prepare our students for the systems analyst job market as well as possible, we analyzed 500 job advertisements posted on Monster.com (www.monster.com 2005) in June 2005 for system analysts. We choose Monster.com for two reasons. First, a study by CareerXroads (www.careerxroads.xom 2004) that surveyed 150+ large companies found that 29.6% of external hires were recruited through job advertisements on the Internet, compared to 5.5% recruitment from newspaper advertisements. Second, Monster.com encompasses jobs from a wide variety of industries and geographical regions.

Issues Examined In Detail

We decided to examine these two general questions by delving deeper and asking the following questions:

- What topics do students perceive to be important?
- Is the students' perception of importance of topics equivalent to students' perception of what topics are important for employers?
- Is the students' perception of importance of topics is influenced by (a) work experience in IT? (b) gender? (c) age? (d) GPA?
- What skills do employers perceive to be important?
- Is the students' perception of importance of topics different from employers' job requirements?

Data Collection

We developed an initial survey (based on content in current SAD textbooks and courses) to identify students' perception of importance of topics. The identified topics were consistent with the topics identified in the Tastle and Russel (2003) survey. The initial survey was pre-tested with several students that had taken one of the SAD classes in an earlier semester, and their input was used to make minor revisions to the survey to improve the clarity and comprehension of the questions asked. The seventeen topics that were used for the survey are shown in Table 1.

Table 1: SAD Topics

Project management skill
Ability to develop Use cases/use case diagram
Ability to develop object-oriented static diagrams (class diagrams, object diagrams, CRC cards)
Ability to delvelop object-oriented behavioral diagrams (sequence diagrams, collaboration diagrams, state chart diagrams)
Ability to develop traditional data models (ER diagrams)
Ability to develop traditional process models (Data Flow Diagrams)
Ability to develop design models (Window navigation diagrams, Network models, Hardware/Software specifications)
Ability to develop user manual
Ability to develop installation manual
Experience in development of real-world project
Teamwork
Communication skills
Other soft skills (leadership, motivation, diversity, change)
Project presentations skills
Software testing skills
Cost-benefit analysis
Cost tracking

We analyzed the content of 500 job advertisements for system analysts on Monster.com (www.monster.com 2005) posted in June 2005 in order to identify employers' perception of the importance of SAD topics/skills for employers. Job advertisements are often used to determine skills sought after by employers (Athey and Plotnicki 1998, Maier et. al. 1998, Todd et. al. 1995). Whereas not all of the system analysts jobs advertised are entry level jobs for freshly graduated students, they give a good overview of the skill set needed for successful professional progress.

Survey Subjects

Forty-four subjects (thirty-eight males and six females) participated in an anonymous study. Subjects were students enrolled in SAD classes taught at a Carnegie Research Extensive University in the Western U.S. They all received extra credit for participation; alternative opportunities for extra credit were offered if someone preferred not to participate. Fourteen subjects were enrolled in a distance education undergraduate course, 24 were enrolled in a senior undergraduate course, 6 were enrolled in a graduate course. All three classes taught the same course content. All except three subjects were Management Information Systems (MIS) majors. The average GPA was 3.56, the average age was 27.1 and the average years of work experience was 2.61. More detailed demographic characteristics are reflected in Table 2.

Table 2: Demographics Characteristics Of Survey Respondents

	N	%
Gender		
Female	6	14
Male	38	86
Age		
20-25	19	43
26-30	17	39
31-35	3	7
36+	3	7
No response	2	5
Work Experience in IT		
0	11	25
1-5	27	61
6-10	5	11

RESULTS—STUDENTS' PERCEPTIONS

The results and discussion are divided into two parts, following the two questions the study attempted to answer. This first part, results and discussion – students' perceptions – describes students' perception of importance of topics and the influence of other factors on their perception of importance. The second part, results and discussion – employer needs–describes the analyses of the job advertisements and their relationship to students' perception of importance.

Importance Of Topics For Students

Students were asked how important they thought specific topics of their SAD classes were. Responses were measured on a 5 point Likert scale, with 1= the topic is not important and 5= the topic is very important. The results, ordered by importance, are shown in Table 3.

The students agreed that all topics were important, but ranked three of the soft skills (teamwork, communication skills and project management skill) highest. These three items also had the lowest variability, so there seems to be a fairly high consensus among students on the importance of these topics. Surprisingly, given the high publicity of object-oriented technology being the technology of the future, object-oriented static and behavioral modeling techniques were ranked the lowest.

Students' Perception Of Importance Versus Students' Perception Of What Topics Are Important For Employers

In addition to their perception of importance of the SAD topics, we asked students how important they thought the topics/skills were for employers. We than compared these importance levels with the importance levels of the earlier question. Paired *t*-tests were performed for each topic. The mean values for each topic and the P-values for the difference between the two groups are shown in Table 4. For only three of the 17 topics, the mean values are statistically significantly different. For object-oriented static modeling and testing, the students' perception of importance is higher than their perception of importance for the employers. We did not expect to see this difference, especially looking at the results from the job advertisement search. Object-oriented static modeling and testing were mentioned in 482 and 481, respectively, of the 500 job advertisement analyzed.

Table 3: Students' Perception Of Importance Of SAD Topics

	N	Min.	Max.	Mean	Std. Deviation
Teamwork	44	4	5	4.73	0.451
Communication Skills	43	3	5	4.56	0.629
Project Management	44	4	5	4.48	0.505
Real World Project	42	2	5	4.43	0.737
Testing	44	2	5	4.30	0.701
Other Soft Skills	42	1	5	4.19	0.804
Traditional Data Modeling	44	1	5	4.09	0.858
User Manual	44	2	5	3.98	0.849
Project Presentations	44	3	5	3.95	0.608
Cost Benefit Analysis	43	2	5	3.93	0.856
Design Modeling	41	2	5	3.93	0.787
Installation Manual	44	2	5	3.89	0.895
Traditional Process Modeling	40	2	5	3.85	0.893
Cost Tracking	43	2	5	3.77	0.922
OO Static Modeling	44	2	5	3.59	0.787
OO Behavioral Modeling	44	2	5	3.55	0.820

The students' perception of importance for communication skills was statistically significantly lower than their perception of importance for the employers. Communication skills were mentioned in 368 of the 500 job advertisements.

Table 4: Students' Perception Of Importance vs. Students' Perception Of Importance For Employers

	Students Perception Importance		Students Perception Importance for Employers		
	#	Mean	#	Mean	P-value
Project Management	44	4.48	44	4.43	0.74177
Use Cases	44	3.36	44	3.16	0.31678
OO Static Modeling	44	3.59	44	3.20	0.03537 **
OO Behavioral Modeling	44	3.55	44	3.27	0.14677
Traditional Data Modeling	44	4.09	44	3.75	0.05866
Traditional Process Modeling	40	3.85	44	3.52	0.10398
Design Modeling	41	3.93	44	3.64	0.13419
User Manual	44	3.98	44	3.95	0.90261
Installation Manual	44	3.89	44	3.84	0.81417
Real World Project	42	4.43	44	4.52	0.52495
Teamwork	44	4.73	44	4.68	0.66168
Communication Skills	43	4.56	44	4.80	0.03933 **
Other Soft Skills	42	4.19	43	4.44	0.11155
Project Presentations	44	3.95	44	4.09	0.36003
Testing	44	4.30	44	3.89	0.01920 **
Cost Benefit Analysis	43	3.93	44	4.00	0.71850
Cost Tracking	43	3.77	44	3.84	0.72074

Importance Of Topics For Students Is Influenced By Other Factors.

The students' perception of importance was analyzed using work experience in Information Technology (IT), gender, age and GPA as grouping factors. None of the factors examined made a statistically significantly difference in the analyses.

DISCUSSION—STUDENTS' PERCEPTION

The fact that students think that object-oriented static modeling is important to them but not so much to employers indicates that educators are doing a good job in emphasizing this topic in the classroom but students are not aware of the usefulness in companies. Both internships in the SAD area and the inclusion of even more real world examples in the classroom might help to alleviate the discrepancy. Also, systems analysts who use object-oriented static modeling could be invited to serve as guest speakers to explain to students how they use these tools in their day-to-day work.

Testing was another skill where students' importance rating was statistically significantly higher than what students perceive to be important for employers. We could explain this by the instructors' efforts to emphasize the importance of testing systems developed as part of the class projects contrasted by the lack of students' real-job experience.

The areas of written and oral communication skills were the only topics where students' listing of importance to the employers was statistically significantly higher than their own perception of importance. Nonetheless, overall communication skills ranked second in the students' list of importance and first in students' perception of importance for employers, so the discrepancy seems to be a difference without a distinction.

RESULTS—JOB MARKET

This section describes the results of the analyses of the job market for systems analysts, followed in the next section by a discussion of the results.

Importance Of Topics: Students' Perception vs. Employers Requirements

The students' perception ranking of importance was determined by asking the students to rank the topics in order of importance with one being the most important topic to seventeen being the least important topic. The employers' perception of importance was determined by how often a topic was mentioned in the job advertisements. The students' ranking of importance is shown in Table 5 where the value was calculated by weighting the responses in reverse order. For example, rank 1 was given 17 points, rank 2 was given 16 points, … rank 17 was given 1 points.

Table 5: Students Importance Ranking

Topic	Value	Ranking
Project Management	660	1
Communication Skills	591	2
Teamwork	583	3
Real-world Project	497	4
Soft Skills	392	5
Testing	389	6
Traditional Data Modeling	352	7
Project Presentations	348	8
Cost Benefit Analysis	337	9
Design Modeling	302	10
OO Static Modeling	299	11
User Manual	298	12
OO Behavioral Modeling	296	13
Use Cases	292	14
Traditional Process Modeling	290	15
Cost Tracking	274	16
Installation Manual	268	17

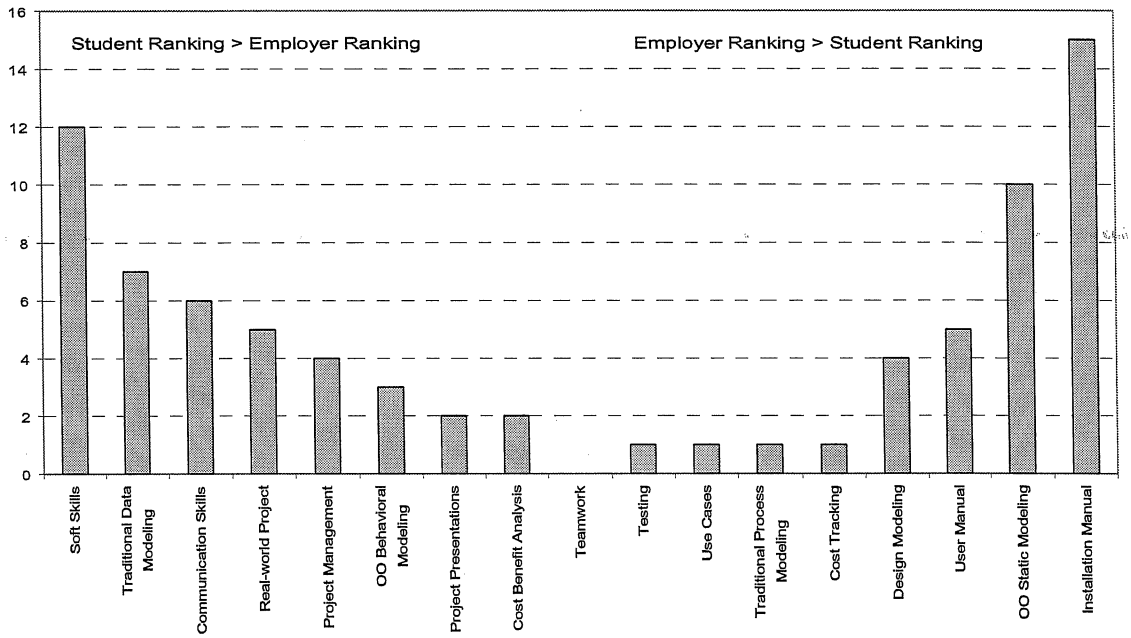
The employers' ranking of importance is shown in Table 6. The employer value represents how often a specific skill was mentioned in the job advertisement. The only topic mentioned frequently in the job advertisements but not included in the survey was the Rational Unified Process (RUP) methodology, which was included in 387 advertisements.

Table 6: Employer Ranking of Importance

Topic	Value	Ranking
OO Static Modeling	482	1
Installation Manual	481	2
Teamwork	452	3
Testing	417	4
Project Management	412	5
Design Modeling	412	6
User Manual	369	7
Communication Skills	368	8
Real-world Project	356	9
Project Presentations	345	10
Cost Benefit Analysis	336	11
Traditional Process Modeling	333	12
Use Cases	238	13
Traditional Data Modeling	229	14
Cost Tracking	214	15
OO Behavioral Modeling	199	16
Soft Skills	156	17

Because of the different measurements a direct comparison of the values was impossible; therefore the absolute differences in the rankings, illustrated in Figure 1, were used to compare the differences. The left side of Figure 1 shows the topics where students' ranking of importance was higher than employers' ranking. For example, students ranked traditional data modeling 7, but employers ranked it 14, so an absolute difference of 7 is displayed. The right side shows the topic where employers' ranking of importance was higher then students' ranking. Both groups completely agreed on the ranking of teamwork, so no difference in ranking is displayed.

Figure 1: Differences in Student Rankings vs. Employer Ranking



We categorized the differences into three groups:

- Students Rankings and Employer Rankings are very similar. Teamwork, testing, use cases, traditional process modeling, cost tracking, cost benefit analysis, project presentations, and object-oriented behavioral modeling fall into this category.
- Students Rankings and Employer Rankings are moderately different. The importance of design modeling and user manual were ranked moderately higher by employers than students, whereas project management, real-world project, communication skills and traditional data modeling were ranked moderately higher by students than employers.
- Students Rankings and Employer Rankings are very different. There was no agreement on the importance of three topics: Other soft skills, which were ranked fairly high by the students but ranked lowest by the employers (5 vs. 17). Conversely, object-oriented static modeling and installation manual was ranked very high in importance for employers (mentioned 482 and 481 times in job advertisements, ranked 1 and 2 in importance) but relatively low (11 and 17) to the students.

DISCUSSION—JOB MARKET

The high ranking of technical skills in job ads is consistent with findings in earlier research by Litecky at al. (2004), in which they propose that technical skills play a significant role as a filter in the first stage of job applicant screening while soft skills assessment is left to the second, choice stage. Technical skills are easier to judge for

students and employers. If an advertisement asks, for example, for the ability to develop object-oriented static models as a required skill and none of the students' course work covered object-oriented design, they know that the chances of getting the job are not very good and therefore might not apply for it. On the other side, the recruiter can easily judge from a resume if an applicant has a specific skill or not and reject the resume if the required skills are not existent.

Self-judgment of soft skills is highly subjective and often depends on self-esteem as well as relative abilities. Students with high self esteem might think their communication/teamwork/etc. skills are excellent, whereas more modest students might judge them as average. Additionally, students that are better than their peers might rank themselves higher when in fact, their skills might be mediocre. Recruiters should assess soft skills through interviews as well as testing.

The problem of self-judgment would also explain the high disagreement of ranking of other soft skills, like leadership qualities, skills to deal with diversity issues, change management skill etc. Whereas these topics and their relationship to SAD are discussed in the classroom, they are fairly difficult to judge for the employers even during the interview process. These skills emerge over time and are often considered for promotion and job advancement.

It is interesting that employers rank the areas of object-oriented static modeling and installation manuals much higher than students do. Anecdotal evidence suggests that students need more explanations of the importance of all areas of object-oriented design and that a paradigm shift has occurred in the SAD world. We also note that the area of installation manuals is a very "real-world" item that would be appreciated by the employer but could not be appreciated by students due to their lack of experience. We also believe that creating excellent installation manuals require extensive use of soft skills that students ranked much higher than did employers. Indeed, it is plausible in a few of these areas, there is an overlap of understanding in the rankings. Nonetheless, it is valuable to examine the rankings as well as the differences.

IMPLICATIONS FOR EDUCATORS

From our study we can see that the trends of job market requirements and skills taught in SAD courses align fairly well, but there are still opportunities to align them better. Students' evaluation of the importance of object-oriented design is not at a level where it should be based on the frequency it is required by employers. As other authors previously concluded, object-oriented design is a growing area. Object-oriented design has now reached a level of acceptance where the need for skillful employees with the ability to apply OOD generally surpasses the need for employees with the traditional design methods skills. We think that educators could drive this point home more efficiently by introducing more real world examples by guest speakers and by utilizing course projects that require object-oriented design tools, such as the Rational Unified Process (RUP).

The job market for systems analysts, just as the broader MIS job market, changes more rapidly then most job markets. It is essential that those of us teaching SAD courses continuously watch this market and observe its trends. The popularity of different design methods change over time and so do the tools used to implement them. Employers often want their employees to possess working skills of specific environments and tools beyond the understanding of the design methodologies. The question of how much emphasis to place on the teaching and use of popular environments and tools is often up to debate.

Instructors of SAD courses also need to prepare students to better understand the place and importance of technical and soft skills in the hiring process. The possession of technical skills is a necessary requirement for systems analyst positions. At the early, filtering stage of the hiring process there is no substitute for these skills. Soft skills, on the other hand, will play an important role in the second, person-to-person stage of the hiring process only. Students need to understand the difference in the importance of these skills to be able to land the desired jobs .

CONCLUSION

The results of interviewing students from different SAD courses at different stages of their careers have yielded some fascinating results. In many different areas, students have a reasonable understanding of the importance of SAD topics, but we can still improve "selling" the importance of both "soft skills" and technical skills such as object-oriented programming design.

Litacky et al.'s (2004) two-stage model of hiring and anecdotal evidence suggests that employers look initially at SAD technical skills to sift out the applicant pool but then look to "soft skills" for making final hiring decisions. To that end, students should be encouraged to develop their skills in both areas. Additionally, recruiters need to be queried regarding the hiring process and the methods they use to assess both technical and soft skills.

SUGGESTIONS FOR FUTURE RESEARCH

Future research must address issues such as whether different skills are used to get hired versus to be successful in job (i.e., technical skills more important to get job; soft skills more important for to be successful in job, etc.). Also, research must address whether computer science students are hired with a greater emphasis in technical skills or whether soft skills are equally as important for them. In addition, the perceptions of importance of technical and soft skills of computer science students should be evaluated and compared to MIS students. Issues such as the effect of relevant experience, the matching of the skill set to the position being filled, and the ability of the candidate to adapt to change must all be examined. In summary, there is still much research that needs to be conducted so that universities can help aspiring SAD students meet and exceed expectations as they enter the information systems workforce.

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