IN THE KNOW: DESIRED SKILLS FOR ENTRY-LEVEL SYSTEMS ANALYST POSITIONS

Guido Lang, Quinnipiac University, guido.lang@quinnipiac.edu
Kiku Jones, Quinnipiac University, kiku.jones@quinnipiac.edu
Lori N. K. Leonard, The University of Tulsa, lori-leonard@utulsa.edu

ABSTRACT

The undergraduate information systems curriculum seeks to prepare students for entry-level information technology positions. In this study, which is part of an ongoing research program aiming to better align the information systems curriculum with employer needs, the desired skills for entry-level systems analyst, business analyst, and project manager positions are identified based on interviews with information technology professionals. As technology continues to change, it is important to understand the changing needs of employers in this area. Based on the interviews, two categories of desired skills can be defined – soft skills and hard skills. Soft skills are comprised of intrapersonal and interpersonal skills, and hard skills are comprised of domain knowledge and technical skills. A discussion of the findings in light of previous work and directions for future research are provided.

Keywords: information systems curriculum, soft skills, hard skills, intrapersonal skills, interpersonal skills, domain knowledge, technical skills

INTRODUCTION

Undergraduate information systems (IS) programs aim to prepare students to obtain positions analyzing, maintaining or supporting information systems as systems analysts, business analysts, or project managers. With the rapid growth of information technology (IT) and employer needs for adequately skilled graduates, many universities offer IS programs using slightly different titles, such as computer information systems (CIS), management information systems (MIS), and business information systems (BIS) [12]. However, given the rapidly changing technological landscape, how do we know what to prepare students for? In other words, how do we know what are the desired skills for IS graduates wishing to become systems analysts, business analysts, or project managers?

The Occupational Outlook Handbook, which is published by the U.S. Department of Labor, collectively refers to the positions of systems analysts, business analyst, business systems analyst, etc. as computer systems analysts and describes the role as follows: "Computer systems analysts study an organization's current computer systems and procedures and design information systems solutions to help the organization operate more efficiently and effectively. They bring business and information technology (IT) together by understanding the needs and limitations of both." [3]. As indicated by the U.S. Department of Labor, the terms computer systems analyst, business analyst, systems analyst, and business systems analyst are often used interchangeably – depending on the preferences of the organization and the industry it operates in. We use the term systems analyst to refer to individuals in positions that fall within the above definition by the U.S. Department of Labor.

Unfortunately, the Occupational Outlook Handbook and the related O*NET database of occupational information [13], which was also developed by the U.S. Department of Labor, provide only vague and general information with regards to the skills desired for entry-level systems analysts. For example, the Occupation Outlook Handbook lists analytical skills, communication skills, and creativity as important qualities. Similarly, the O*NET database lists very general knowledge areas (e.g. computer and electronics, English language, customer and personal service) along with general skills (e.g. critical thinking, active listening) and abilities (e.g. information ordering, oral comprehension).

As part of an ongoing effort to improve our IS curriculum by better aligning it with employer needs, we wanted to better understand the desired skills for entry-level systems analysts. The following section describes previous work, which is followed by a description of our methods.

PREVIOUS WORK

Desired skill sets for entry-level systems analysts have certainly changed over the years. As technology and technique changes, so are the expectations of what a graduate from a IS program will have upon entering the workforce. Cappel [4] developed a survey based on information found through literature review as well as input from his program's advisory board. The survey was administered to employers associated with the author's large, public university in the Midwest. The result of the survey showed that the development of programming skills was an essential component. They also felt, on average, that the students should take about three programming courses prior to graduation. In addition, the results indicated that the respondents rated the non-technical skills (such as ability to learn, teamwork, and communication) even higher than technical skills.

An exploratory study was conducted to try to match employer needs with IS curriculum [7]. The authors developed their survey by first having a roundtable discussion with practitioners to determine various job titles and responsibilities. They administered the survey in two parts. Part A was sent to 225 professionals in the authors' university's service area. This first survey collected information regarding the company and their anticipated hiring needs. Seventy-four professionals responded. Of those, 50 agreed to part B. Ultimately, 24 participants completed part B of the survey. Part B asked about the companies' technologies and job skills needs. The top 3 technologies that were indicated by participants as being relevant to their companies' needs were Windows, MS SQL Server, and Visual Basic. However, all of the listed technologies were relevant to at least someone. The two top future hiring expectations were programming and networking.

Another study surveyed IS/IT recruiters from a random sample of 500 companies from the D&B's North American Million Dollar Database [5]. The participants were asked about recruiting, required knowledge/skill for IS entry-level positions, and specific software knowledge that IS entry-level employees should possess. When asked about the most important factors in hiring for a full time position, 40% indicated communication skills. The authors categorized skills sets into four areas: core IS knowledge and skills, organizational knowledge, interpersonal, and personal skills/traits. Among all of the skills, participants indicated that all of the interpersonal and personal skills/traits (e.g., team skills, communication, critical thinking, etc.) were rated much higher than any of the other core IS knowledge and technical skills. The highest ranking specific software knowledge/skills for IS entry-level employees is web browsing and web programming languages followed by email software and SQL.

Plice and Reinig [11] looked to determine if there needed to be a shift in the balance between the business and technical focus of the undergraduate IS program. They surveyed graduates of these programs in regards to their managerial, technical, and interpersonal communication responsibilities. The participants were also asked about their preferences to certification requirements. Results of the study indicated that these graduates move into roles where both business and interpersonal communication skills are needed. Also, that as the graduates move along in their careers, they favor their business content knowledge over the technical aspects.

Another study utilized a taxonomy created from literature that assembled 42 skills into four areas: IS core knowledge, technical proficiencies, business expertise, and personal attributes [9]. They surveyed 153 IT professionals from 6 organizations regarding what they felt was the most important skills for entry-level employees. Results indicated that soft skills from the personal attributes category came out as the most important. In particular, problem-solving, critical thinking and team skills were identified. However, items in the technical proficiencies category were also considered very important. Specifically, knowledge about databases, programming languages, object-oriented, and web development skills were noted. The participants felt that knowledge regarding specialized software, such as ERP systems and decision support systems, were not important for entry-level employees. The participants also indicated that ethics/privacy and security issues from the business expertise category were highly needed.

Aasheim et al. [1] conducted a longitudinal study looking at the differences in what IT managers felt were important skill requirements for entry-level IT employees. The first survey was conducted in 2006 and the second in 2010. The top 12 skills/traits remained the same for the personal and interpersonal categories. Honesty and integrity ranked the highest. In regards to technical skills, the top 5 remained the same over the 5 year duration. Specifically, the ones noted as important were operating systems, security, hardware, networking, and database.

Wilkerson [14] surveyed alumni from a Northeastern US university in regards to the skills, both technical and non-technical, which were important for people in the MIS field. In addition, the survey requested information regarding any gaps in skills sets. There were six categories that the skills divided into: core technical, core managerial, organizational, interpersonal, personal, and technical competencies. These categories were developed by adapting other studies' categories. The three most important skills identified all came from the personal category: accomplishing assignments, dependability, and managing time effectively. In fact, all 15 items that are classified as personal can be found in the top 20 most important skills. In regards to skill gaps, all of the statistically significant skills gaps are from the personal and interpersonal categories. This suggests that more time needs to be devoted to these areas in an MIS curriculum, especially given the most important skill sets are also these.

Through the years and numerous studies regarding what skills entry-level IT professionals need, it is clear that the personal and interpersonal skills remain at the top of the list. However, it is important to note that while the technical skills were not necessarily at the top, they are still considered very important. As technology changes, universities strive to keep up with what is the latest buzz area. However, based on previous studies, it may be that what needs to be changed is how and how much of the non-technical skills are being addressed. Bailey [2] conducted a study focused solely on the non-technical skills needed for IT professionals. In her study, she found that some of the highest ranking non-technical skills included problems solving, team work and the ability to adapt to the new technologies and languages. This is consistent with the previous studies discussed above. Perhaps these are areas in which both technical and non-technical could be combined.

METHODS

This study is part of a larger, ongoing research program which aims to better align the IS curriculum with employer needs. We conducted telephone interviews with ten (10) IT professionals, including systems analysts, IT consultants, IT project managers, and senior IT managers from large consulting, insurance, and pharmaceutical companies. We recruited participants through our personal networks as well as the alumni network of our universities. Participants were selected based on their experience as computer systems analysts as well as their experience managing recent IS graduates in this role. To ensure an open and honest interview, we guaranteed anonymity and confidentiality to the participants. As a result, we cannot reveal the specific names, titles, or companies involved in the interviews. Each interview lasted between 30 and 60 minutes and took place between August and October 2014. Interviews were not recorded, but detailed notes were taken to capture the essence of the responses. We used a semi-structured interview format, in which we began by asking questions from an interview guide (see below) and then continued with additional probing questions based on responses from the participants. Since the goal of this study is to help identify potential necessary skill sets for entry-level systems analysts, we felt it was best not to ask about specific skills, but rather to allow the participants to come to these using their own knowledge.

Interview Guide

1. What is your current role within your organization?
2. For what roles have you hired CIS graduates recently?
3. How do you train entry-level hires in these roles?
4. Which skills or competencies should CIS graduates possess to do well in these roles?
5. Looking five years ahead, which skills or competencies will become more important for CIS graduates in these roles? Which will become less important?

The interview notes were analyzed following guidelines for qualitative content analysis [8]. In particular, we followed the procedure of inductive category development in which we grouped and formed categories as close as possible to the original interview responses. First, we identified common responses across respondents. Next, we grouped the responses into categories of soft skills and hard skills. The labels for our categories came from respondents and we decided to keep these labels as they appear to be commonly used. Finally, we sub-divided the responses in the soft skills category into intrapersonal skills and interpersonal skills, and the responses in the hard skills category into domain knowledge and technical skills. The following section presents our findings.

FINDINGS

Based on our interviews, the desired skills for entry-level systems analyst positions can be categorized into two broad categories – soft skills and hard skills. We use the term hard skills to refer to domain-specific abilities, which are associated with the job of a systems analyst. We use the term soft skills to refer to domain-general abilities, which are needed to effectively apply hard skills in the workplace. As such, the soft skills and hard skills identified in this study should be seen as complementary [6].

Soft Skills

Desired soft skills include a number of intrapersonal skills and interpersonal skills. Intrapersonal skills are talents or abilities that reside within the individual and aid him or her in problem solving [10]. Participants frequently mentioned two intrapersonal skills that are particularly important for entry-level systems analysts. One of them is the ability to *break a complex problem into smaller parts*. An example of this skill in practice would be the ability to take a problem, such as lackluster adoption of a new information system, and divide it into smaller problems, such as lacking user motivation, training, and misaligned incentives. The second important intrapersonal skill is the ability to *think things through*. Oftentimes, it is precisely the ability to deduce all possible consequences from a decision involving an information system that makes for a valuable systems analyst.

Interpersonal skills address the cognitive abilities of individuals relating to their interaction with other individuals. Five interpersonal skills emerged as core to the systems analyst profession. Given that the systems analyst position bridges business and IT functions, systems analysts need to be able to *work in teams*. Moreover, the teams frequently include members outside of the IT function, which poses additional challenges to effective teamwork that need to be handled by systems analysts. Furthermore, the role of a systems analyst requires gathering input and feedback from various stakeholders. Thus, a systems analyst needs to be able to *facilitate workshops, meetings, and conference calls*. This includes being able to help a group stay on topic and supporting people in speaking openly and equally – be it via face-to-face or computer-mediated communication. Similarly, systems analysts are frequently required to *conduct interviews*, which is a skill that includes rapport building and empathy. Again, due to the nature of their position, systems analysts have to *influence people who don't report to them* directly. For example, a systems analyst might have to convince a department manager that a particular information system is not the ideal choice. Such a task requires an ability to build trust with people and convincing them to do something, without relying on formal authority. Lastly, another key interpersonal skill is the ability to *communicate with different audiences*. The audiences that systems analysts communicate with include internal and external stakeholders across different functions (e.g. IT, marketing, finance, accounting, manufacturing) and hierarchical levels (e.g. lower-level staff, middle management, senior management).

Table 1 summarizes the intrapersonal skills and interpersonal skills that together form the soft skills desired of university graduates wishing to become systems analysts.

Table 1. Soft Skills

Intrapersonal skills	Interpersonal skills
Graduates should be able to:	Graduates should be able to:
a) Break a complex problem into smaller parts b) Think things through	a) Work in teams b) Facilitate workshops, meetings, and conference calls c) Conduct interviews d) Influence people who don't report to them e) Communicate with different audiences

The following section describes our findings relating to hard skills.

Hard Skills

We found that hard skills required for entry-level systems analyst positions are comprised of domain knowledge and technical skills. Domain knowledge refers to the theoretical understanding of domain-specific content as it relates to systems analysts. Five discrete areas of domain knowledge were frequently cited among our participants. *Project management*, or the understanding of how to plan and organize resources to accomplish a successful project, is important for systems analysts due to the fact that most of their work is project-based. Similarly, a solid understanding of the various *systems development methodologies*, which are the specific frameworks used to plan and organize the process of developing an information system, is paramount for systems analysts. Waterfall and agile (e.g. scrum, extreme programming) are examples of frequently mentioned systems development methodologies. In addition to in-depth knowledge of these methodologies, entry-level systems analysts need to know when to apply a particular methodology. Another important area is *development estimation techniques*. These refer to specific processes and tools used to predict the amount of effort required to develop an information system. Examples mentioned by our participants include function points and story points. In addition to managerial knowledge, entry-level systems analysts also need certain technical knowledge. In particular, this includes an in-depth understanding of *database design*, or the knowledge of how to produce a data model for a database. In addition to being able to produce and understand common database design artifacts, like entity-relationship diagrams, systems analysts need to be keenly aware of issues relating to data integrity and access rules. Lastly, systems analysts are required to have a good understanding of *enterprise architecture* – i.e. the organizing logic for business processes and IT infrastructure. Although participants did not mention particular tools or frameworks relating to enterprise architecture, the need to understand issues arising from a lack of enterprise architecture was frequently cited.

Technical skills are the practical abilities related to the domain-specific content, which are required for the job of a systems analyst. With regards to technical skills, participants stated that entry-level systems analysts need to be able to *extract data from databases using structured query language* (SQL). Specifically, systems analysts need to be able to use SQL joins (to combine rows from two or more tables) along with basic SQL functions (e.g. sum, average, count). Moreover, systems analysts are expected to be able to *use all Microsoft Office products, including Visio and Project*. Given that the core activity of systems analysts is to communicate within and across functions, they need to be able to use the tools of the trade at an expert level.

Table 2 summarizes the domain knowledge and technical skills that together form the desired hard skills for university graduates aiming for an entry-level systems analyst position.

Table 2. Hard Skills

Domain knowledge	Technical skills
Graduates should have knowledge of:	Graduates should be able to:
a) Project management	a) Extract data from databases using structured query language (SQL)
b) Systems development methodologies	
c) Development estimation techniques	b) Use all Microsoft Office products, including Visio and Project
d) Database design	
e) Enterprise architecture	

The following section discusses the findings in light of previous work.

DISCUSSION

This study identifies the desired skills for entry-level systems analysts based on interviews with IT professionals. The findings indicate that both soft and hard skills are needed to be successful. Soft skills include both intrapersonal and interpersonal skills. Among the intrapersonal skills identified were the ability to break complex problems into smaller parts and thinking issues through. In order for IS students to gain these skills prior to entering the job market, faculty can focus on these issues in the classroom. Breaking down problems and thinking through them is integral to project work and can be tied directly to the hard skills desired. More specifically, a project management (i.e., domain knowledge, hard skill) course can be designed that focuses on identifying a problem and breaking it

down into manageable components and thinking through each portion before proceeding to the next. This will be done in a series of milestones throughout the life of the project in the classroom. Where it is easy to identify how this skill can be managed in the classroom, the execution of this skill is not as easy. As for interpersonal skills, five major skills are identified: working in teams; facilitating workshops, meetings, and conference calls; conducting interviews; influencing people; and communicating to varying audiences. While some of these issues are currently addressed in IS curriculum, such as working in teams and conducting interviews, others need to be addressed more readily. For example, the skill of communicating with varying audiences cannot always be easily gained in the classroom setting. However, if the curriculum can allow for live projects, students can gain exposure to real clients who do not meet the traditional mold of teacher or student, of which students are more comfortable interacting with. A live client project will allow the students to gain the desired skill that IT professionals expect of entry-level systems analysts.

In the hard skills category, two areas are identified: domain knowledge and technical skills. Most IS curriculum addresses the domain knowledge to a large extent. Project management, systems development methodologies, and database design are classes offered in most programs. However, students may have limited exposure to estimation techniques given that most projects are fictional and do not have substantial consequences for poor estimations of time or money. However, students are introduced to the concepts and their importance. Also, the size of the IS program usually determines the magnitude of exposure that students have to enterprise architecture. Smaller programs can introduce such concepts but not give the hands-on expertise that IT professionals desire. In the technical skills category, the interviews revealed the desire for SQL skills and knowledge of all Microsoft Office products. The curriculum can easily address basic skills in SQL in a database course. Microsoft Office products can also be addressed in the curriculum but will vary by University.

Given these categories, it appears that the hard skills (i.e. domain knowledge and technical skills) are most easily addressable in IS curriculum, whereas the soft skills (i.e. intrapersonal skills and interpersonal skills) could be more difficult to address. For example, technical skills such as SQL can be taught with precision and either a student understands the concept and can use it or he/she cannot. A soft skill such as communicating with others is not as easy. There are varying degrees of ability. Whereas most everyone can speak, communication of key ideas and concepts is different and takes skills that cannot be as easily addressed and mastered in the IS curriculum. Therefore, it will take a more discern effort by the faculty to develop and teach these skills.

This study is a first step in a larger research program aimed at improving the IS curriculum through better alignment with employer needs. As such, this study is not without limitations. First, although qualitative insights were gained from the interviews, the small sample size severely limits the ability to draw generalizable conclusions. Second, although great care was taken to take thorough notes during the interviews, the lack of transcribed audio recordings prevents using direct quotes to substantiate the findings. Nevertheless, findings from this study will be used to determine which types of skills should be included in a wider reaching survey of IT professionals. Next steps for this research program will include questionnaire development based on findings and distribution to IT professionals across the US. This will help to gain knowledge of needed skill sets across the US rather than in one particular region as the majority of previous research has reported. With this knowledge, IS programs can prepare students to not only work in their immediate location, but also in other parts of the country. Future research should seek to further this study by surveying universities to determine which skills are currently being taught.

CONCLUSIONS

Teaching in order to employ IS students means that faculty must focus on the desired skills of IT professionals. In order to do this, IT professionals need to periodically be surveyed in order for programs to keep up with the ever-changing IT field. This study finds that entry-level systems analysts must have both soft and hard skills in order to be successful. Intrapersonal skills, interpersonal skills, domain knowledge, and technical skills are all necessary for new systems analysts. Faculty must focus on instilling these skills in students prior to their first job. Some skills are easily developed in the classroom whereas others will take more thought and preparation. However, it is essential that the skills are addressed so that IS students can become productive systems analyst professionals. Next steps in this research program include surveying IT professionals from across the US to weigh in on the specific skill sets needed for entry-level systems analysts.

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