

**What Skills Do Students Need? A Multi-Year  
Study of IT/IS Knowledge and Skills in Demand  
by Employers**

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Recommended Citation: Cummings, J. & Janicki, T. N. (2020). What Skills Do Students Need? A Multi-Year Study of IT/IS Knowledge and Skills in Demand by Employers. *Journal of Information Systems Education*, 31(3), 208-217.

Article Link: <http://jise.org/Volume31/n3/JISEv31n3p208.html>

Initial Submission:	5 June 2019
Accepted:	17 October 2019
Abstract Posted Online:	4 June 2020
Published:	8 September 2020

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ISSN: 2574-3872 (Online) 1055-3096 (Print)

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# **What Skills do Students Need? A Multi-Year Study of IT/IS Knowledge and Skills in Demand by Employers**

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## **ABSTRACT**

In the fields of information technology and information systems, faculty must consistently adjust curriculum to meet the demands of the field. However, a challenge they often face is understanding what should be covered, especially given the limited number of courses most universities are able to offer. This research explores the knowledge and skills demanded in the field by surveying a variety of employers across various roles. The survey focused on IS/IT professionals with the inclusion of management who may oversee these professionals. Additionally, those involved in hiring IT/IS professionals were also surveyed to evaluate future hiring needs across various roles. A variety of technologies were examined, including databases, operating systems, networking technologies, and cloud platforms, to understand the technologies currently being utilized at organizations. Furthermore, specific skills (e.g., programming languages, general business, etc.) across a variety of roles were explored to understand what skills are currently sought by employers. The goal of this research is to understand the importance of various technologies and skills to better prepare students for the workforce. This is part of an ongoing study that has evaluated changes in the field over the past 15 years.

**Keywords:** Job skills, Information & comm. technologies (ICT), Curriculum alignment, Employment

## **1. INTRODUCTION**

Information Systems (IS) and Information Technology (IT) graduates continue to be in high demand by employers. According to the United States Bureau of Labor Statistics (2018), computer and technology jobs are expected to grow by 13 percent between 2016 and 2026. This is higher than the average of all business major occupations. The report also indicates a variety of technology occupations that continue to be in high demand, including Information Security Analysts (+28%), Software Developers (+22%), Web Developers (+15%), Data Base Analysts (+11%), and System Analysts (+9%). With the increased demand for IT professionals, there is increased pressure to prepare future IT professionals with the knowledge sets needed to succeed.

The challenge IS and IT faculty encounter is to design and continuously upgrade the curriculum to stay current and relevant to industry needs. There has been significant research examining the skills needed for both graduating students and IT professionals in the past. Legier, Woodward, and Martin (2013) reported that there are several problem areas for developers of IS programs that need to evolve as industry needs change. These problem areas include:

- How to meet employer needs in changing IT and IS professions;
- How to determine what knowledge should be included in basic Information Systems courses;
- How to balance training and certification desires of students with foundation knowledge of a topic area;
- How to incorporate frequent advances in technology into the same total number of courses.

Further complicating the complexity of remaining current and relevant is the need to also maintain school wide accreditations such as those set by the Association to Advance Collegiate Schools of Business (AACSB). This accrediting agency has recommendations and/or restrictions on the breadth of courses that must be offered within accredited schools which, in turn, can potentially place limits on the number of credits offered in the IS/IT discipline. Thus, faculty need to remain focused on curriculum development that is most relevant in an ever changing environment while balancing the limitations set by accrediting bodies.

The research presented in this paper focuses on understanding the technological knowledge and concepts currently demanded within the IT/IS field. The goal is to help universities prepare students with the appropriate set of skills to meet the increased demand within the market. This includes

examining a breadth of topics from conceptual knowledge skills sought by employers to general IT/IS topics important to organizations today (e.g., virtualization, data analytics, cloud services, etc.). Additionally, both general technologies and specific applications/programming languages (e.g., MySQL, C#, Python, etc.) are evaluated to understand their importance to organizational effectiveness in today's environment. The current study is an expansion of previous research over the past 15 years (with surveys conducted in 2003, 2008, and 2013) which enables us to present the current needs as well as a longitudinal perspective of changes in the past 15 years.

## 2. LITERATURE REVIEW

There have been many approaches taken to understand the shifting knowledge and technological needs within the IT industry. These approaches generally revolve around examining employer needs (e.g., Burns et al., 2018) or matching technology skills and knowledge content to those being taught (e.g., Mills, Chudoba, and Olsen, 2016). This section will discuss these and other recent approaches to understanding the changing marketplace needs.

Examining employer needs has been a frequent approach used by researchers. A common technique has been to analyze current IT/IS job placement advertisements. A study by Burns et al. (2018) reviewed general technology-related, online job listings over a four-month period and found that potential employers tended to focus on "soft skills" such as communications and teamwork in addition to the technical skills needed for the position. Lee and Han (2008) also investigated job placement advertisements but focused specifically on entry-level programmer/analyst positions. They reported that programmer/analysts need to have a range of skills from programming to technical expertise as well as general business skills. These studies found that, in today's marketplace, individuals can no longer rely solely on IT skills alone as business and interpersonal skills are gaining in importance to employers.

An alternate approach to examining employer needs through job placements has been to directly survey those involved in the hiring process. Surveying IT managers and workers across the U.S., Aasheim, Williams, and Butler (2009) found that soft skills were desired for entry-level IT professionals. Interestingly, although they desired soft skills as well as technical skills, employers indicated that knowledge of primary business functions (accounting, finance, etc.) was less important. Dillion and Kruck (2008) took a similar approach by asking employers to match desired skills based on model curriculum. While the focus of their study was Accounting Information Systems (AIS) model curriculum, there were similar results to previous studies in which a mix of both technical and soft skills are needed by graduates. Sala (2011) took a different approach by examining IT recruiter needs with results suggesting a strong need for programmers/developers, project managers, and help desk support. Again, these results suggest a diverse skillset needed by graduates entering the IT/IS marketplace.

While research from manager/employer expectations provides a general overview of skills needed, research has also focused on more specific skills needed through examining skills by position as well as surveying recent graduates to understand

the technology and skills professionals interact with directly. Legier, Woodward, and Martin (2013) found many recent graduates were working in positions such as end user support, management of computer systems, and software development. Additionally, graduates from the study indicated that the current curriculum from their university "somewhat prepared" them for their current position. Another study examining recent alumni found IT professionals should have a variety of skills including technical, inter-personal, and knowledge of multiple business areas (Wilkerson, 2012). Other studies have focused specifically on various roles, such as programmer analysts or system analysts, to understand what skills were required for an entry-level position in a given role (Tastle and Russell, 2003; Lee and Han, 2008). However, research in knowledge and skills has not been limited to analyzing alumni and employers.

An alternative approach to understanding skills needed by future IT/IS professionals is to examine current course content as well as suggested curriculum. Mills, Chudoba, and Olsen (2016) approached their research of employer needs by examining course offerings in technology areas at AACSB schools. They were specifically interested in looking at the changing environment for big data, visualization, and business data analytics. Thus, their research builds on the perceived newer technology needs that are being taught at AACSB schools. The Association for Computing Machinery (ACM) and IEEE Computer Society are also actively developing model curriculum to help guide universities in their course offerings. While all the approaches listed above help improve the delivery of content to students, there is a lack of research focusing on experienced workers in the field in addition to those directly involved in the hiring process that may lead to future gaps in curriculum in higher education.

The goal of the current research was to focus on surveying a wide range of IT professionals with varying levels of experience and identify their current and future needs in both skills and knowledge. This paper extends prior surveys assessing the changing needs of the IT community over the past 15 years (Janicki et al., 2004; Janicki et al., 2009; Cummings, Janicki, and Kline, 2014). In more detail, we consider the current technology needs in the areas of databases, programming languages, networking, and operating systems platforms, as well as the anticipated changes in the near future. Finally, we evaluate how these needs have changed compared to the previous studies. As an interesting sideline, the original research included mobile operating systems like "Palm Pilot" which was originally believed to have continued importance with respondents never anticipating the iPhone operating systems to be developed. Needless to say, the technologies surveyed have changed over the past 15 years.

## 3. METHODOLOGY

Similar to prior studies, the survey was developed to examine (1) the technologies organizations are currently using and expected to use in the future and (2) the job skills/knowledge needed for current/anticipated jobs for recent graduates (both undergraduate and graduate). The goal was to answer the following questions:

- What organizational technologies are currently in use and projected to be used in the future?

- What IT knowledge and skills are required/needed by all IT graduates?
- What is the demand for graduates across varying IS/IT related categories?

Following prior study designs, the survey was developed using a multi-phase process involving an advisory board of IT professionals, faculty, and, lastly, survey distribution. This process is described in the subsequent sections.

### **3.1 Initial Survey Development**

During survey development, a roundtable discussion was conducted with a corporate advisory board at a large, regional university. The advisory board consisted of 25 members that represent regional and national organizations of varying sizes (10 employees to over 1000 employees). These members are primarily employees from their respective organization's IT department and interact with many of the technologies included in the survey. Additionally, IT management who manage and hire entry-level IT professionals were also members of the board and participated in the discussions. The roundtable goals were to understand what areas were important to IT professionals while identifying major technology areas. Faculty from the Information Systems and Information Technology department led the roundtable discussions.

During the first roundtable discussions, a faculty representative worked with advisory board members to identify major trends or changes in technology in their respective fields. Following this discussion, the group walked through previous surveys from the prior studies to evaluate relevancy in the current market as well as suggesting new areas to evaluate that were not covered in prior studies. The first roundtable discussion resulted in the following technological areas:

- Cloud Platforms
- Databases
- Development Languages
- Networking/Communication (Both Software and Hardware)
- Operating Systems Platforms

In addition to the categories identified above, the roundtable discussion also included an evaluation of potential job categories that would fall under the technological areas. This resulted in the following job categories:

- Business/Systems Analyst
- Data Analyst
- Database Admin/Analyst
- Management
- Networks/Security
- Project Management
- Software Developer
- IT Strategy

Once the job categories were identified, the roundtable further discussed the specific knowledge/skills needed for each of the jobs. This was done to provide a clear picture for educators of future IT professionals to incorporate specific skills into their courses that directly relate to the needs within

industry. For example, under the Business/Systems Analyst job category, the skills needed to perform effectively within the role were identified which included topics such as requirements analysis/gathering, process analysis, structured design, and system design.

### **3.2 Final Survey Development**

Adjustments were made based upon the suggestions from the advisory board during the initial survey development, and additional research was done to ensure all technologies and job categories were represented in the survey. The next step was to take the broad categories from the survey development phase and develop sub-categories of the technological areas. This discussion occurred during the following advisory board meeting in which specific technologies (including brand names) were identified within each category. The groups went through several iterations to make sure all possible sub-categories were captured and there was consistency across areas. The list of technologies/software was finalized based on the advisory board's experience and thoughts as well as ongoing importance. For example, professionals evaluated the networking category and specific technologies and brands were included as a subcategory. These included Cisco, Linux/Unix, Virtualization, VOIP, and Windows.

In addition to the subcategories, questions centered on technologies used and future importance were developed to understand what industry professionals currently use now. Due to the evolving nature of the IT field, future importance was based on a two-year time horizon. After the subcategory selection was complete, the survey instrument was finalized and included general questions, such as company size, organization type, employee functional area, and general demographics (age, gender, location, company size, industry, and job title).

### **3.3 Pilot Test**

Once the survey was developed and finalized within the advisory board, a pilot test was conducted to ensure that the survey questions were clear to participants, all areas were appropriately covered, and average completion time was 10 minutes or less. A preliminary survey was emailed to industry professionals, which directed them to complete the online survey and provide feedback. Twenty-six participants completed the survey during the pilot test. The average completion time was below 10 minutes. Based upon feedback, minor changes were made to the survey instrument, and it was deemed ready for distribution.

## **4. SUMMARY STATISTICS**

The survey was distributed to over 2,500 IT professionals throughout the U.S. which targeted both professionals within the field as well as managers/supervisors who oversee these professionals. These professionals were selected based on participation in IT conferences, alumni from the university's CS/IS/IT programs, and through the use of a national research firm specializing in targeting IT professionals across the U.S. Additionally, the survey could only be completed by those participants who identified themselves within an IS/IT role (or management/hiring manager of those roles). If they did not meet the criteria, their responses were not included in the final results. A total of 151 professionals completed the survey. This

included a variety of organizations (Table 1) and organizational sizes (Table 2). Corporations were the highest represented in the survey at 47% with almost half of those responding working at large organizations of over 500 employees.

Organization Type	%
Corporation	47%
LLC	10%
Education	8%
Healthcare	11%
Government	19%
Non or Not for Profit	4%
Sole Proprietor or Partnership	1%

Table 1. Organization Type

Number of Employees	%
< 20	14%
21-100	16%
101-499	21%
500-999	15%
1000-9999	18%
10000+	16%

Table 2. Size of the organizations

Of the participants surveyed, 27% were female and 73% were male. The number of female participants showed an increase from prior studies (~20% in previous surveys). The participants' educational background included high school education (4%), Associate's degree (15%), Bachelor's in an IT related field (35%), Bachelor's in a non-IT field (16%), Master's in an IT related field (9%), Master's in a non-IT field (17%), and Ph.D. (4%).

Across all participants, the average tenure within the field was 14 years, and employees were at the current employer for an average of 8 years. Additionally, participants from a variety of organizational roles and management responded to the survey (see Table 3). The representation of the various organizational roles remained similar from the previous survey with the exception of fewer IT Strategy roles and increased management participation in the current survey (see Table 3 for comparison).

Organizational Role	2018	2013
Business/Systems Analysis	10%	8%
Data Analyst	4%	2%
Database Admin/Analyst	2%	5%
Management	25%	17%
Networks/Security	10%	9%
Project Management	9%	7%
Software Developer	14%	17%
IT Strategy	5%	15%
Other IT	21%	20%

Table 3. Organizational Role

## 5. RESULTS

The results that follow are organized by the three original research questions posed: technology currently used and predicted use, job skills, and employment. First, the results describing current technologies in use and predicted importance

are analyzed. This is followed by an overview of suggested skills needed by individuals pursuing a career in various technological roles. Finally, an overview of current and future employment needs are evaluated.

### 5.1 Current and Future Technology Importance

This section asked participants to respond to a series of questions concerning technologies currently used within their organization and the expected importance to the field over the next two years. These questions were asked to all participants that were not involved in hiring or serving in a supervisory role. The reason to exclude these types of participants was to focus on those who were more likely to be directly engaging with the technologies on a regular basis as opposed to those supervising these employees.

In addition to presenting the results from the current study, this research parallels prior surveys of IT workers conducted in 2013, 2008, and 2003. The prior surveys were similar to the current with slight adjustments to include additional technologies that had not been included in previous studies. Thus, the subsequent sections will also compare the changes to levels of importance across the previous studies. All tables display the importance ranking which was calculated as follows: (5) for extremely important, (4) for more important, (3) for same importance, (2) for less important, and (1) for not at all.

**5.1.1 Operating systems.** As with the past surveys, expectations of five different OS Platforms (including Mobile Platforms) were surveyed to understand their importance over the next two years. As with previous surveys, the Windows platform was rated as the highest importance with 90% surveyed stating it will have the same or more importance moving forward. This was followed by Linux/Unix (50%) with MacOS (45%) still trailing as it was rated with the third highest importance in operating systems (see Figure 1).

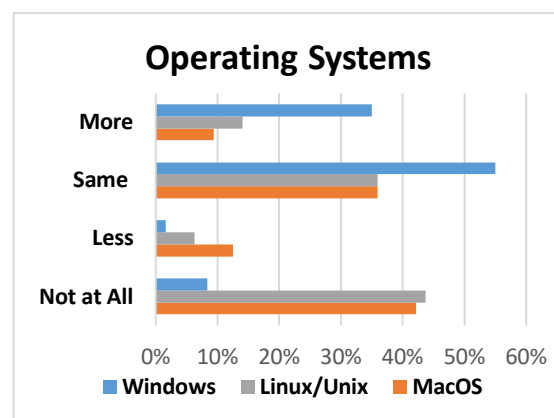


Figure 1. Operating System Expected Importance

Mobile operating systems were also evaluated. iOS was reported to have a greater importance compared to Android. However, both rated high with the importance over the next two years staying the same or increasing for both iOS at 90% and Android at 67%. The lower importance of Android may be due to the participants in the study stating they more frequently use

iOS compared to Android. Figure 2 shows the results for mobile operating systems.

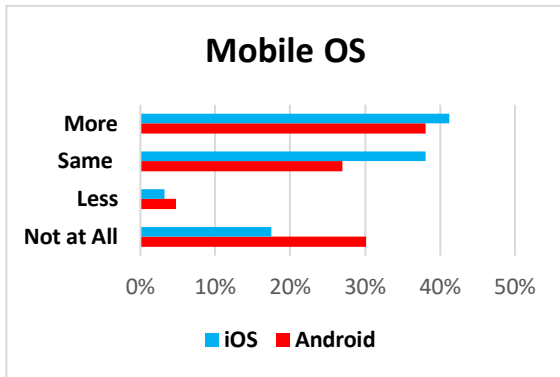


Figure 2. iOS & Android Expected Importance

**Prior Study Comparison:** As compared to the results in 2013, there was an increase in importance across all operating systems platforms. Interestingly, the largest increase was from the iOS platform suggesting the continued importance of mobile. In fact, iOS and Windows had equivalent scores of importance this year for the first time. Another significant finding was the increased importance of Linux/Unix, which had the second largest increase behind iOS. This increase may be for a variety of reasons from the open source nature of Linux to its use on various hardware devices (see Table 4 for full results). Further research is recommended to understand the exact reasons behind these increases.

Product	2018	2013	2008	2003
Windows	4.1	3.8	3.9	3.9
iOS	4.1	3.1	--	--
Android	3.4	3.1	--	--
Linux/Unix	3.6	2.9	2.6	2.9
Mac OS	3.1	2.6	1.5	--

Table 4. Operating Systems – Rankings of Importance

**5.1.2 Networking/Communication.** Within the Networking and Communication category, the survey captured both software and hardware. For example, software technologies such as Windows Networking were included as well as hardware products like Cisco Technologies. Windows networking continues to be important in this category with 88% stating the importance going forward will remain the same or increase (see Figure 3). However, virtualization had the highest expected importance with 49% of participants stating virtualization will be more important going forward, showing a continued need for professionals with virtualization experience.

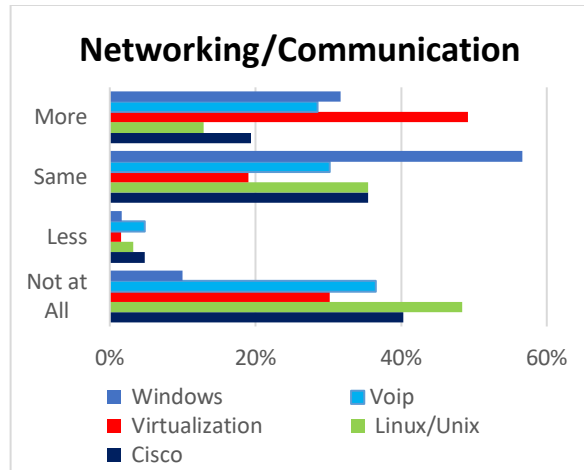


Figure 3. Networking/Communication Expected Importance

**Prior Study Comparison:** An interesting finding in this category was the only product appearing to increase in importance from the prior study was Windows (see Table 5 for details). Virtualization fell slightly in importance from previous years but remains important to organizations moving forward. Linux/Unix remained the same from the previous study. Surprisingly, Cisco products appeared to fall the most from 2013. This may be from the availability/popularity of other networking technologies available or participants this year may not use these technologies in their existing position. Further analysis of the data confirmed that survey respondents this year did not currently use Cisco technologies in their organizations, which may explain the drop in importance. VOIP dropped slightly from the previous study. Based on the results, the future survey may need to be adjusted to include new networking technologies.

Product	2018	2013	2008	2003
Windows	3.8	3.7	3.5	3.9
Virtualization	3.5	3.7	--	--
VOIP	3.1	3.4	--	--
Cisco	2.8	3.2	2.4	3.9
Linux/Unix	2.6	2.8	2.3	2.9

Table 5. Networking/Communication – Rankings of Importance

**5.1.3 Databases.** MS SQL was rated the highest database platform with 74% stating the importance will remain the same or increase in the next two years. MySQL followed this closely at 61% while Oracle and DB2 decreased in importance from previous studies. Figure 4 displays the results found for MS SQL and MySQL.

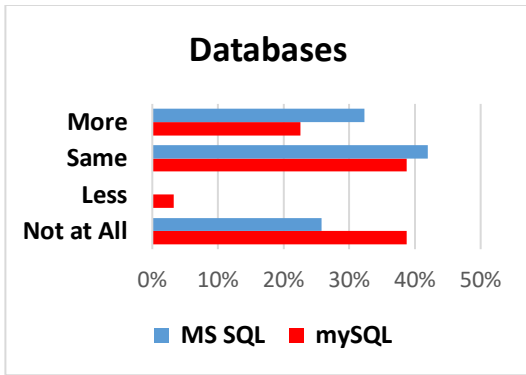


Figure 4. MS SQL and MySQL Server Expected Importance

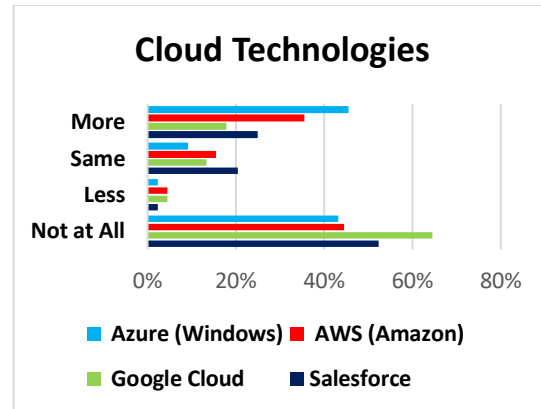


Figure 5. Cloud Platform Rankings of Importance

**Prior Study Comparison:** Within Database products, both MS SQL Server and PostgreSQL increased from previous years. The increase in PostgreSQL and the consistent importance of MySQL suggest the increase of popularity of open source within organizations (which may also be the reason for the results concerning Linux). This is confirmed by external sources as well. DB-Engine (<https://db-engines.com/en/>) is an online resource ranking database products by popularity, jobs available, number of technical discussions, etc. This site found an increased popularity of PostgreSQL, doubling in popularity from 2013 to 2018. The comparison of current results to prior surveys can be found in Table 6.

Product	2018	2013	2008	2003
MS SQL Server	3.5	3.3	3.0	3.6
MySQL	3.1	3.3	2.1	2.1
Oracle	2.7	2.8	2.7	2.9
IBM DB2	2.0	2.2	1.8	1.6
PostgreSQL	2.4	2.1	1.6	1.6

Table 6. Databases – Rankings of Importance

**5.1.4 Cloud platform.** In the 2013 study, cloud platform technologies were introduced into the survey. The current survey again asked the importance to understanding cloud technologies moving forward. The results (see Figure 5) suggest mixed findings for the importance of cloud technologies in the next couple of years. While slightly over 50% of respondents feel AWS and Azure importance will remain the same or be greater in the next two years, the results suggest Google Cloud and Salesforce will be less important moving forward.

**Prior Study Comparison:** Cloud technologies was originally introduced to the survey in 2013 which now gives us the opportunity to analyze the change in importance over the past five years (see Table 7). There appears to be a shifting importance from Google to AWS and Azure compared to the previous survey. While the results for this year suggest Salesforce is not as important as Azure or AWS, a comparison to the 2013 results suggests it is still gaining importance.

Product	2018	2013
AWS	3.1	2.6
Azure	3.2	2.6
Google	2.3	2.9
Salesforce	2.7	2.2

Table 7. Cloud Platform – Rankings of Importance

**5.1.5 Development languages.** Development languages were evaluated differently from the previous categories. Participants were asked to rate the level of knowledge needed across 13 different programming languages. The scale included no experience (rating 1), fundamental (rating 2), working (rating 3), and expert (rating 4). Results are shown in Table 8.

Rank	Product	Rating
1	JavaScript	2.41
2	HTML 5	2.29
3	CSS 3	2.18
4	C#	2.00
5	XML	2.00
6	jQuery	1.82
7	ASP.NET MVC	1.76
8	PHP	1.65
9	Java	1.59
10	ASP.NET	1.59
11	C++	1.41
12	Python	1.35
13	JSP	1.18

Table 8. Development Language Level of Knowledge Importance

The results suggest professionals should not have expert knowledge in one specific language. However, web development languages appeared to be important as participants

suggested a fundamental to working knowledge in JavaScript, HTML5, and CSS3. In the 2013 study, ASP.net, PHP and C# were ranked in the top three while JavaScript was ranked fifth. While it should be noted that many of the languages were closely rated, there does appear to be a shift from previous studies in programming languages.

**5.2 Skills by Role**

In addition to technologies used, the survey collected information regarding the skills needed for individuals working in a specific role (e.g., Business Analyst). Due to the targeted nature of these questions, the number of respondents for each category varied depending on their stated organizational role. Table 9 includes the top five desired knowledge areas, listed in order of importance, based on the job category.

Compared to the previous study, changes were seen throughout the various roles. The knowledge areas of Web Services and Process Modeling are now thought to be more important than Structured Design and Software as a Service for the Business/Systems Analyst role. Additionally, results suggest security/networking skills has changed slightly to an increased emphasis on administration as well as security. Within Software Development, there appears to be an increase in need for versioning, as Version Control Management made the top five skills list. While Project Management had many of the same skills needed, Change Management and Inter-Organization Relationships came in as the top skills needed. Finally, Data Analyst and DB Administrator saw similar skills needed this year. However, there were minimal respondents for these job roles so knowledge skills in these areas should be evaluated further.

Job Category	Knowledge Areas	
	2018 Results	2013 Results
Business/Systems Analyst (n = 17)	Requirement Analysis	Requirement Analysis
	Process Analysis	Process Analysis
	System Design	Structured Design
	Process Modeling	System Design
	Web Services	Software as a Service (SaaS)
Network and Security (n = 14)	TCP/IP	Data Security
	Network Admin	TCP/IP
	Windows Admin	Network Security
	Network Security	Security Policies
	Desktop Security	Desktop Support
Software Development (n = 21)	Object Oriented Programming	Data Structures
	Data Structures	Structured Programming
	Development Languages	Object Oriented Programming
	Design Patterns	ASP.Net
	Version Control Management	Design Patterns
Project Management (n = 15)	Change Management	Team Management
	Inter-Organization Relationships	Resource Scheduling
	Risk Management	Risk Management
	Team Management	Leadership
	Planning and Scheduling	Planning and Scheduling
Data Analyst (n = 6)	SQL Query	SQL
	Raw Unstructured Data	DB Programming (tie)
	SQL Reporting	Database Administration (tie)
	DB Programming	Data Cleansing / Integration
	Data Warehousing	Backup / Restore
Database Admin (n = 3)	SQL Query	SQL Query
	Tools (SSIA/SSAS/SSRS)	SQL Reporting
	Data Warehousing	DB Design Concepts
	DB Programming	Tools (i.e. SSIS, SSAS, SSRS)
	SQL Reporting	Raw/Unstructured Data

**Table 9. Knowledge Skills by Job Role**



In addition to specific knowledge areas by role, the survey also asked all participants (regardless of role) to answer questions concerning the importance of overall IT and business skills for incoming employees. The results can be found in Table 10.

<b>IT Knowledge</b>	<b>Rank of Importance</b>
Database Skills	1 (tie)
Systems Administration	1 (tie)
Business/Systems Analysis	3
Networks / Security	4
Project Management	5
Software Development	6
Data Analytics	7
Cloud / Virtualization Concepts	8
<b>Business Knowledge</b>	<b>Rank of Importance</b>
General Communication Skills	1
General Writing Skills	2
Data Analytics	3
Accounting	4 (tie)
Management	4 (tie)
Finance	6
Statistics	7
Supply Chain and Logistics	8
Marketing	9
Economics	10

**Table 10. General Business Skills by Rank of Importance**

Database, Systems Administration, and Business/Systems Analysis were the top three IT knowledge skills suggested by participants in the study. This is particularly interesting given the number of database administrators responding was relatively low in this survey (2% of total participants). This suggests that providing students with general IT skills across multiple areas is still significant for future employment. Aside from IT skills, General Communication Skills and General Writing Skills were the top two general business skills, which is similar to previous surveys. An interesting finding of this survey was the increased importance of general business skills surrounding Data Analytics. While this was listed lower for specific IT knowledge surrounding analytics, the findings for business skills suggest we should be teaching general data analytics to IT students in order to provide a foundation in analytical techniques such as predictive and prescriptive analysis approaches.

**5.3 Employment Growth by Occupation**

As part of the survey, participants were asked whether they were involved in either the hiring process or served in a supervisory role. This resulted in 85 participants who were asked about hiring expectations across the previously discussed job roles/categories. The participants were directed to approximate the number of employees in each category they hope to hire in the next two years. Results for both the current study and prior surveys are presented in Table 11.

<b>Job Categories</b>	<b>Future Growth</b>	<b>Prior Survey Ranking</b>		
	Current Study	2013	2008	2003
Software Development	1	6	1	1
Business/Systems Analyst	2	3 (tie)	3	5
Other IT Skills	3	7	4	4
Network/Security	4	5	2	2
Project Management	5	2	*	*
Data Analyst	6	1	*	*
Database Admin/Analyst	7	3 (tie)	5	3

**Table 11. Occupations and Hiring Expectations**  
(\*denotes category did not exist during the survey year)

There were significant changes to the job categories compared to the prior survey in 2013. While project management and data analyst were previously ranked as the top two areas of growth, this year’s survey found software development and business/systems analyst to be the two major areas of growth. This is consistent with trends found in industry publications in which developer and analyst were ranked within the top 30 best jobs with increased projected jobs available and ongoing low unemployment rates (U.S. News, 2019).

In addition to the employment expectation analysis, the survey also examined the value of certifications in the hiring process. The same participants from the results above were asked:

- (1) Do you consider certifications in the hiring process?
- (2) What do you consider to be important certifications?

Over 62% of the participants stated that certifications were considered during the hiring process. Of the certifications listed, the results in Table 12 suggest that certifications within networking and security remain consistently important for those in that specific field. Additionally, with Project Management Professional (PMP) certification tied for second, there is still a need for highly qualified project managers.

<b>Important Certifications</b>	<b>Rank</b>
CISCO CAN	1
Microsoft CSE	2
PMP	2
CompTIA A+ Tech	4
CompTIA Network +	5
CISSP	6
AWS Solutions Architect	7
CISM	8
Certified Risk IS Control	9
CIS Auditor	10

**Table 12. Professional Certifications Considered in Hiring Process**

## 6. CONCLUSIONS

The survey resulted in a variety of findings for both technological knowledge and skills demanded by today's employers. The findings stress the importance for IS/IT educators and professionals to stay abreast to this changing world to enable students and themselves to remain relevant.

For educators, the continued demand for software developers and business analysts remains high and suggests that IS curriculum continue to incorporate courses in programming and analysis/design. The results concerning development languages suggest educators should consider incorporating web development and open source programming into their curriculum based on the growing importance of HTML, CSS, and JavaScript programming. For business analysts, the continued education and knowledge of gathering requirements and understanding different development methodologies is important. Also evident is the need for increased security emphasis in the curriculum.

In addition to specific technological skills, basic business communication skills (e.g., oral and written) remains high in the list of talents desired by supervisors and IS/IT recruiters. Moving up to third in the rankings of overall business skills is the need for IS/IT professionals and students to have a working knowledge of basic data analytics concepts. This emphasizes the need to include data analytics concepts throughout the curriculum and not solely in a data analytics course.

For professionals, the survey provides insights into the skills that continue to grow in popularity over the past 15 years. Employment growth in the areas of software development and business/systems analyst remains strong while areas such as data analyst have shown declines. This may be a result in the demand in analytics across a variety of IT roles suggesting that analytics has become engrained in many of the IT functions throughout an organization. Thus, jobs solely concerned with data analytics alone are declining while having the skills in analytics may be important across all the positions listed.

Finally, an evaluation of the future importance across various technologies provided additional insight for both educators and professionals. The importance of mobile operating systems continues to increase from previous studies with iOS having equivalent importance as Windows in the near future. From a networking perspective, the role of virtualization continues to gain importance as it had the largest number of respondents in the category ranking it to be more important in the future. Lastly, cloud continues to gain importance compared to prior studies with every category, except for Google, increasing from the prior study.

## 7. FUTURE RESEARCH AND REMARKS

As the survey continues to be administered in the future, the questions will need to be adjusted to reflect technological change. The focus of the study is on specific skills and technologies facing IT/IS graduates. However, this is still a limited number of technologies explored and there may be a need to expand further to capture technologies not currently surveyed. The advisory board does help narrow the focus of technologies on the survey. One improvement would be to include additional advisory boards at multiple universities to increase the diversity of those designing the survey instrument.

There were some limitations to the current study worth noting. Compared to previous studies, we approached this study by reaching out beyond the east coast for participants. However, many of the participants came from the eastern U.S. Future research will strive for a broader set of participants and may include additional researchers across the country to increase the diversity of responses. Another limitation concerns the categories chosen to evaluate. While there are numerous emerging technologies, we limited the technologies in the survey to those identified by the advisory board.

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ISSN 2574-3872