Linking Programmer Analyst Skills to Industry Needs: A Current Review

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Abstract

This paper reports the analysis results of 500 job descriptions for the programmer analyst position, to address what employers are seeking in a programmer analyst. More specifically, this research addresses skill sets of Information Technology and Information Systems (IT/IS) that are considered critical, usable and of importance in relation to the current workforce. The results are discussed in terms of their implications considered critical to higher education curricular offerings in IT/IS-related programs.

Keywords: Programmer Analyst, Job Skills, Information Systems Curriculum, IT Employment

1. INTRODUCTION

Information Technology (IT) has rapidly become one of the largest segments of the US economy accounting for 11.6% of private sector payroll and 7.1% of GDP (CompTIA, 2016). This rapid expansion is a challenging and an ongoing undertaking for educators in higher education institutions that prepare IT professionals for the industrial demand. To meet this challenge, industrial data must be continually collected and analyzed. Data about IT job postings and required job skills are useful; once analyzed, the data can be used to determine the relevancy and the adequacy of IT educational programs and courses for satisfying the needs from the industry.

This study reviews job postings for programmer analyst positions. "The programmer analyst is more than just a programmer, this person is responsible for analyzing businesses and developing software applications using programming languages" (Lee & Han, 2008). The main objective of this research is to determine what skills employers desire in a programmer analyst in 2018. It asks the following questions:

1. What are the important skills required for a programmer analyst?
2. What are the important soft skills required of a programmer analyst?
3. What degrees are relevant for a programmer analyst?
4. What experience is necessary, if any, for a programmer analyst? How important is experience?

The answers to the above questions would be of value to the following institutions and individuals:

1. IT departments in education and in industry, as an aid in determining standards for the education and selection of IT professionals.
2. Students enrolled in IT programs.
3. IT professionals who are motivated toward self-improvement and career advancement.

2. LITERATURE REVIEW

Previous studies have surveyed employers to identify and evaluate skill sets that are necessary for the IT job market. These studies have been useful in understanding how the needs of the industry have changed over time. With the rapid change and advancement of technology, the technical skills required by present job recruiters should be adapted to this changing technology. In contrast, soft skills such as communication, social, business, etc., are not required to change rapidly and should be more static in job postings.

A recent study by Jones, Leonard, and Lang (2018) identified the top five knowledge areas in order of importance for entry level IS jobs: security, programming, systems development methodologies, database design, and project management. The remaining ordered knowledge areas identified included web development, Information Systems (IS) trends, enterprise architecture, disaster recovery, development estimation techniques, networking/telecommunications, e-commerce, management, finance, accounting, and marketing.

In comparison to the recent 2018 results, Nord and Nord (1995) surveyed analysts and identified that technical skill requirements of database concepts, mainframe hardware, mainframe software, knowledge of programming, and programming security, as well as system skills requirements of user training, output design, defining data requirements and project management were most important. Additionally, management skill requirements such as communication and decision making were in high demand, along with business skill requirements of management and accounting.

Lee and Han (2008) conducted an analysis of skills requirements for an entry-level programmer analyst. They collected and analyzed 837 job postings on Fortune 500 corporate websites for three years. The results indicated that technical skills related to development and software as well as the soft skills related to social skills and business were much needed. Comparatively, less attention was given to technical skills in architecture/network and hardware, or soft skills in management and problem-solving.

Aken, Litecky, Ahmad, and Nelson (2010) extracted approximately one million unique IT job descriptions from various search engines and reported the following top five technical skills as having been listed the most: security, C/C++, SQL, programming, and Microsoft operating systems.

Asheim, Shropshire, Li, and Kadlec (2012) conducted a survey of IT managers across the country and reported on skills/traits for entry-level, full-time IT workers. The top ten technical skills identified by IT managers for these workers were: operating systems, security, hardware,

networking, database, packaged software, systems administration and maintenance, integration of IT solutions, business intelligence, and web systems development. Enterprise resource planning (ERP) and virtualization ranked the lowest while programming, systems development life cycle (SDLC) methodologies and human-computer interaction were not among the top ten skills.

Erstad (2017) applied a real-time job analysis software to examine more than 700,000 programming-related job postings during 2016 and 2017 to determine the necessary skills for computer programmers. The data indicated that the in-demand technical skills for programmers in 2016-2017 were SQL, Java, JavaScript, Microsoft C#, Linux, .NET Programming, Oracle, C++, Python and XML. The top soft skills for programmers were communication skills, problem-solving, teamwork/collaboration, and research and creativity.

In addition to technical skills, other researchers have indicated the diverse soft skill sets needed by IT professionals include: flexibility, change management, creativity, interpersonal, communication, problem- solving, conceptual, strategic management, and continuous improvement (Cappel, 2002; Choong, 2005; Lerouge, Newton, and Blanton, 2005; Bailey and Mitchell, 2000).

Fang, Lee, and Koh (2005) conducted a national study of the perceptions of IS recruiters and reported that interpersonal and personal skills and traits are more important than other attributes such as IS knowledge and technical skills.

Echoing the findings of Fang et al (2005), Gallagher, Kaiser, Simon, Beath, and Goles (2010) indicated that while both technical and non-technical skills are important for a programmer analyst, the skills most critical to retain in-house employees and most sought-after in new mid-level employees are non-technical skills such as project management, business domain knowledge, and relationship skills. These soft skills enable IT departments to work effectively with other departments, internal users, and external customers and suppliers.

The literature review has shown the change over time in the preferences of technical skills and soft skills in program analysts and related job positions. This literature review revealed only a single survey that looked at the skills set of a programmer analyst, specifically, which was published in 2008. We, therefore, examined the current industry demand in the preferred skills set and how such a demand may influence the IT/IS curricula in higher education.

3. METHODOLOGY

The authors reviewed job postings in February 2018 from the website of postjobfree.com. This website was used instead of the, perhaps, more familiar sites such as indeed.com because the terms of service at postjobfree.com have no restrictions and are noted as 100% public. Indeed.com and other job sites have very specific restrictions that prevent the extraction of data and threaten legal actions if data are extracted. Postjobfree.com has no such restrictions. This site allows you to search a job title and then returns up to 500 open jobs and their descriptions.

The authors entered "Programmer Analyst" as the search term and obtained 500 returned job descriptions for programmer analyst. Postjobfree.com includes job postings world-wide with a primary focus on the United States. Although the site allows for geographic specification, this was not entered to allow for geographic dispersity.

The data were entered into an Excel spreadsheet and then specific words and combinations of words were extracted and counted. Function words such as "a," "the," "for," etc. were excluded, as well as, general words that do not reflect job-related skills.

This classification was determined and reviewed by all authors. Although an analysis was performed using seven, six, five, four, three, two, and one-word phrase(s), the authors decided to focus on the key one and two -word phrase(s) because the longer phrases were not consistent across all job descriptions.

Next, the terms were organized based on specific categories supported by the prior work of Bailey and Mitchell (2000), Cappel (2002), Choong (2005), and Lerouge et al. (2005). The categories used were: Soft Skills, Years of Experience, Business Skills, Programming Languages, General Systems Skills, Specific Technical Skills, Education, Vendors, the DIKW (Data, Information, Knowledge and Wisdom) knowledge hierarchy (Rowley, 2007), and other key terms. In order to simply results, some singular and plurals were combined, such as process and processes, program and programs, etc.

4. ANALYSIS OF DATA AND FINDINGS

As noted, one of our main objectives was to determine what employers are seeking in a programmer analyst in 2018.

Research Question 1: What are the important skills required for a programmer analyst?

To answer the first research question, we prepared and examined the ten categories ranging from general systems skills to wisdom hierarchy.

Table 1 summarizes the most common general systems skills terms which include the general skills of experience, development, systems, application, analysis, design and requirements. Each of these general skills have over 685 occurrences in the 500 job postings for programmer analyst.

Table 1 suggests that broad-based analytical and problem-solving skills are most important for industry needs. This is an interesting result to the educators as they need to continue to emphasize and expand the trainings of these skills to students.

General systems skills that were found in our review of the 500 job descriptions for programmer analysts update skills found by prior researchers. General skills such as experience, development, systems, application, analysis, design, documentation, maintenance and implementation are all important terms/skills in the Lee and Han (2008) survey, as well as in our study, suggesting that many general skills are still important ten years later.

Some other skills were uncovered in our analysis that were generally missing from the 2008 study. These include requirements, support and testing. This suggests these skills have become more important over the past decade. Maintenance was also new supporting the 2012 study by Asheim, Shropshire, Li, and Kadlec that included maintenance as a top ten entry-level IT skill.

The most important term, as shown in Table 2 (see Appendix), is the specific technical skill of software. This is not surprising given the common understanding of a programmer; however, it is significant that it comes first in the list of most mentioned skills in programmer analyst job descriptions.

General Systems Skills	
Words	**Count**
Experience	1427
Development	1382
Systems	1327
Application	1217
Analysis	1032
Design	718
Requirements	686
Support	509
Technology	394
Testing	378
Solutions	301
Problems	263
Maintain	262
Documentation	217
Implementation	191
Reports	189
Software development	97
Information systems	95
SDLC	93
Improvements	86
Application development	84
Processing	77
Troubleshooting	77
Operations	64
Design development	56
Software applications	52
Development experience	50
Systems development	40
Test cases	40
HCM	14

Table 1: General Systems Skills Referenced

According to Table 2, there continues to be a need for workers with software and programming knowledge as each emerge with the highest word occurrences for specific technical skills. This remains consistent with the Nord and Nord study from over 20 years ago, which identified specific technical skills such as programming, software, database, mainframe, and hardware. In these major technical areas, there has been little change in need over two decades. The Lee and Han (2008) study also included many of the same

skills that the authors found including: programming, technical, computer, web/Internet, server, database, mainframe, coding and hardware; however, our study includes many new skills that were not needed ten or twenty years ago. These include integration, agile, MVC, scripting, mobile, cloud, AWS, SOAP, REST and web services. Clearly, job requirements are changing, and many new skills are in demand.

Although there continues to be a need for programming, it does not consistently rank as the most sought-after skill. According to Lee and Han (2008) programming was rated highest. Our study found software highest followed by programming. The Jones et al. (2018) study listed programming and database in their top five skills.

Specific languages or environments, in which programmer analysts should possess knowledge, was separately collated, as shown in Table 3. Surprisingly, SQL topped the list with 521 occurrences; this confirms the need for solid database training and manipulation in IT-related programs. There is a strong need for .NET skills, as well, with 361 occurrences. The number of occurrences of other skills is a bit more scattered with only C#, Java, JavaScript, C and ASP receiving over 100 mentions, each. It appears that general business and technical skills hold more importance than language specific skills with the exception of, perhaps, SQL. This could be due to the constantly new, emerging languages/environments in the IT world.

Languages required by employers have changed significantly over time. A study by Noll and Wilkins (2002) identified the top languages as Perl, JavaScript, SQL, Java, Visual Basic, C++, C, and COBOL. Lee and Han (2008) reported that Java, Visual Basic, and COBOL ranked the highest among the total number of job postings that they evaluated. According to Table 3, in our study, Java ranks fourth, Visual Basic ranks eighth, and COBOL ranks sixteenth. SQL, which was our highest ranked language/environment, was not identified by Lee and Han. Other languages identified by Lee and Han include: C++, PowerBuilder, and Delphi, which do not rank in our study. Surprisingly, C, which was the fifth most important language in 2008 and a top language in 2002 still made our list in 2018. Perl has dropped off the list from 2002. New languages such as C#, JavaScript, ASP, XML, and PHP were also ranked in our study. Our study, generally, supports that of Erstad (2017), who found SQL, Java, JavaScript, Microsoft C#, Linux,

.NET Programming, C++, Python, and XML to be the most popular languages; however, we did not find Python or Linux as major languages/environments in our study.

Languages/Environments	
Words	Count
SQL	521
.NET	361
C#	149
Java	119
JavaScript	119
C	106
ASP	102
Visual	100
HTML	99
Languages	93
SharePoint	82
Studio	80
XML	80
Access	78
Visual Studio	71
COBOL	67
VB	60
PL/SQL	58
CSS	57
JS	43
RPG	39
JCL	33
PHP	20
VBA	20
Visio	19
Ajax	19

Table 3: Languages Environments Referenced

Jones et al. (2018) found the top reported technical skills to include: Microsoft Office, Database/Data Warehouse/SQL, programming languages, enterprise system software, web development software, project management software, decision support systems, and statistical packages.

Table 4 depicts vendor-specific skills, which are in demand. The data contained in this table reveals a diverse group of requirements with one

exception, Microsoft. Microsoft or MS had a count of 300 in the 500 job descriptions. As a result, the inclusion of Microsoft exposure appears to be important for IT-related degree programs. After this, the largest count was Oracle and followed by SQL Server at 177, and 160, respectively. All other vendors were mentioned less than 100 times. Erstad (2017) included Oracle as a major skill need in their study. Lee and Han (2008) do not discuss vendor-specific skills as part of their findings.

Vendors	
Words	**Count**
Microsoft/MS	300
Oracle	177
SQL Server	160
IBM	77
Windows	65
DB2	53
SAS	44
Teradata	16
Syncsort	13

Table 4: Vendors Referenced

A common question is whether business skills are important skills for a programmer analyst to possess. Table 5 clearly indicates that the answer to this question is "yes". The most important business skill mentioned is project/projects. The ability to successfully complete and manage specific projects is suggested by 543 occurrences of "project or projects" in the 500 job descriptions. Business, management, and process/processes are also mentioned more than 300 times, each. A solid grounding in business skills appears to be a vital requirement for programmer analysts and needs to be included in university programs to prepare students for entry into the workforce.

Business skills have been important across the decades; however, the importance given to some business skills seems to have changed drastically. Nord and Nord (1995) included management and project management as key programmer analyst skills. Lee and Han (2008) reported organization skills and planning as the most important "management" skills. Comparatively, our study ranked these skills quite low; as shown in Table 5, planning is rated ninth while organizational skills are not ranked. In their analysis, Lee and Han (2008), found project management to be ranked fourth and general knowledge of business

ranked the highest; whereas, in our study, project management was ranked eleventh, and business skills are ranked second.

Business Skills	
Words	**Count**
Project or Projects	543
Business	533
Management	341
Processes or Process	301
Procedures	192
Implement	115
Research	112
Documents	100
Planning	65
Analyzing	53
Project Management	50

Table 5: Business Skills Referenced

In general, business skills remain important from 2002 to present. Skills mentioned in 2018 that were not mentioned in 2008 are processes and procedures. The increased emphasis on organizations for unified methods has made these important skills.

Research Question 2: What are the important soft skills required of a programmer analyst?

As shown in Table 6, the most mentioned soft skill is team/teams, followed by communication/communication skills, written/writing, create, and standards. Team/teams has 438 occurrences in the 500 postings and is clearly the most important soft skill.

We found the second most important soft skill to be communication/communication skills, which has 286 occurrences in the postings that we examined. Based on past research, this particular soft skill is consistently sought. Lee and Han (2008) also studied soft skills; they found that the need for 'communication skills' was mentioned at least once in 65% of the 837 postings for a programmer analyst that they examined.

Soft Skills	
Words	Count
Team/Teams	438
Communication/Communication Skills	286
Written/Writing	237
Create	130
Standards	120
Independently/Work Independently	119
Understand	88
Objectives	69
Organization	65
Assistance	65
Analytical	64
Verbal	59
Interpersonal	43

Table 6: Soft Skills Referenced

Our findings are generally in line with other researchers. Nord and Nord (1995) found communications and decision making to be sought after skills. Clagett (1997) noted the importance of team building, interpersonal relations, and written and oral communications. Lee and Han (2008) noted interpersonal skills, communications skills, and independent/self-motivated. According to Aasheim, Shropshire, Li, and Kadlec (2012) the highest ranked skills included honesty and integrity, attitude, willingness to learn new skills, and communication skills - both oral and written. Jones et al. (2018) conducted a survey of 73 US-based and international employers and reported that: willingness to learn, critical thinking, attitude, honesty/integrity/technical, analytical skills, and ability to work in teams were among the top six skills found in their study. Jones et al. (2018) found oral communications skills ranked tenth in their study.

The lower occurrences, 130, and below, for other soft skills is a bit surprising given the work of other researchers. For example, while we found a mere 43 occurrences of the term interpersonal in the postings that we examined, Lee and Han (2008) found interpersonal skills as the most referenced social skill. They found that it was referenced at least once in 65.9% of the job postings that they examined.

Research Question 3: What degrees are relevant for a programmer analyst?

Table 7 was used to answer the third research question. This table notes that the word degree occurs 308 times in the 500 postings; however, bachelor's is only mentioned 187 times. Thus, less than half of the job postings that we examined included the word bachelor's.

Educational	
Words	Count
Degree	308
Bachelor's	187

Table 7: Education Referenced

Our findings are in sharp contrast to that of previous studies. For example, Lee and Han (2008), found that a large majority (95.1%) of the 837 postings for a programmer analyst that they analyzed sought a person who held at least a bachelor's degree. One possible cause for this discrepancy, as noted by Lee and Han (2008), is that their study focused solely on job postings from Fortune 500 companies, who may have stricter recruitment requirements; whereas, our study had no such restrictions.

Research Question 4: What experience is necessary, if any, for a programmer analyst? How important is experience?

Years of experience has 377 occurrences in the 500 job postings. The most common number of years is 3, followed closely by 5 (refer to Table 8). With only 377 occurrences, many postings do not specify years of experience. We did not find years of experience studied in other research work.

Years of Experience	
Words	Count
3 years	136
5 years	114
2 years	81
4 years	46

Table 8: Years of Experience Referenced

Other Findings

Two other items were uncovered as a result of our analysis. Table 9 lists other key terms that were not part of our research questions. These terms refer to the environment that programmer analysts must work within at organizations. The mentions of users and clients/customers were found to be of very high importance with 475 and

357 occurrences, respectively. Similarly, Nord and Nord (1995) cited user training as a top skills requirement. Interestingly, quality and functional were only mentioned 145 and 137 times, respectively. Other terms occurred less frequently.

Other Key Terms	
Words	**Count**
User/Users/End users	475
Client/Customer/Customers	357
Quality	145
Functional	131
Opportunity	114
Legacy	12

Table 9: Other Key Terms Referenced

Table 10 addresses the wisdom hierarchy. As proposed by Rowley (2007), the wisdom hierarchy starts with data, then rises to information, then knowledge, and, finally, wisdom. As shown, no job posting mentioned wisdom; however, most had the second highest level of "knowledge". This may suggest programmer analysts are not merely coders but expected to have knowledge and/or provide knowledge development within their organizations. This supports the definition of a programmer analyst as "more than just a programmer, but a person who is knowledgeable and is responsible for analyzing businesses and developing software applications using programming languages" (Lee & Han, 2008).

DIKW	
Words	**Count**
Knowledge	447
Data	428
Information	362
Wisdom	0

Table 10: Wisdom Hierarchy Referenced

5. SUMMARY AND CONCLUSIONS

In this paper, the authors have examined 500 postings for programmer analyst positions throughout the world, with primary focus on the United States. They have performed word counts to determine employer's most sought after hard and soft skills. Doing this, they have found that broad-based analytical and problem-solving skills are the most important along with soft skills dealing with team/teams and communication/communication skills. These findings can be used to make a case for the continued inclusion of such skills in the higher education curricular offerings in IT-related programs. Overall, we have found many commonalities with major surveys done in 1995 and 2008; however, much has also changed in programmer analyst skills requirements over the past twenty years.

The impact and influence of this study on academic programs can be interpreted through insights gained from a review of each table. In general systems skills, experience was the most frequently used term. This suggests that hands-on and real-world exercises should be incorporated into academic programs. Likewise, all SDLC skills such as analysis, design, and requirements are still relevant. Specific technical skills have remained important over the past twenty years, as well, including software, programming, programs, and code, indicating that these skills are also still relevant. A variety of specific skills can be perused for inclusion in academic programs such as AWS, JSON, and REST.

The most popular programming languages have changed over time and now are headed by SQL, .NET, C#, Java, and JavaScript and should be considered for presence in technical IT degrees. Exposure to Microsoft, Oracle, and SQL Server would seem to be needed in education for programmer analyst positions, as they are in the most demand. Vendor neutral or open source do not seem to be as attractive to employers.

Business skills remain very important to the education of programmer analysts. Projects, business, and management are highly sought-after skills and academic IT programs ought to emphasize the understanding of how business functions and how IT can contribute to organizational success.

The importance of team skills in the soft skills category suggests that team projects and team-related exercises should be built into the curriculum. Having adequate writing skills also remains important.

This research found the word degree occurs in at most 308 of the 500 postings for a programmer analyst, while the word bachelor's is found in at most 187 postings. This research suggests that, perhaps, a degree, especially a bachelor's degree, is no longer a must for employment as a programmer analyst. The need for a degree may be replaced by the need for experience, as shown

through the 1427 occurrences that were found, of the word experience.

Many of the postings that were examined did not specify a necessary number of years of experience. When a number of years of experience was specified, the most common was 3, closely followed by 5. Similar to the requirement of a degree, the prerequisite for a specific number of years of experience may be replaced by the specific, pertinent experience, itself.

Further research should be undertaken with larger datasets to confirm these findings; however, the authors believe this work represents a significant contribution to academic leaders, students, and professionals by highlighting current programmer analyst needs.

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Appendix

Specific Technical Skills	
Words	**Count**
Software	650
Programming	592
Program/Programs	547
Programmer	542
Technical	466
Computer	442
Code/Coding	422
Web	319
Server	241
Database	205
Computer science	159
Related field	121
Mainframe	120
Engineering	106
Operating	100
Databases	99
ERP	98
Developer	87
Hardware	87
Integration	83
Security	67
Agile	65
MVC	65
Scripting	55
Web services	50
Web based	48
Relational	46
Programming experience	43
Excel	41
Programming languages	40
CICS	34
Linux	32
Mobile	30
JSON	24
Certification	20

CRM	20
APIs	20
Apps	20
Cloud	19
AWS	17
SOAP	17
REST	16
WCF	16
Bootstrap	15
HTML5	15
z/OS	11
J2EE	11
Skype	11
JDE	11
OAuth	10
FTP	10
UML	10

Table 2: Specific Technical Skills Referenced