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Information Technology Job Skill Needs and Implications for Information Technology Course Content

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Abstract

As the demand for Information Systems (IS) and Information Technology (IT) graduates remains strong, it is imperative that the curriculums in IS and IT programs meet employer needs. IS and IT educators encounter a continuing challenge to ensure that their courses and curriculum stay up to date with new and evolving technological changes in the field as well as being relevant to the business community. This research summarizes the results of an employer survey of IS/IT professionals. It is similar to other employer surveys in querying job-hiring expectations, but unique in that it drills down to identify the detailed job skills required for specific occupations. The article also compares the results of employer surveys conducted in 2008 and 2003. The survey indicated the growth of new occupation areas for IT/IS professionals in Big Data and its many components. There was also increased demand for IT/IS professionals possessing project management skills.

Keywords: IT employment, IS curriculum, IT curriculum, employer needs

1. INTRODUCTION

The demand for Information Technology (IT) professionals continues to be one of the highest in the United States. According to the US News Jobs Report, IT occupations comprise four of the Top Ten Best Jobs for 2013, with healthcare workers the other major occupation group in the top ten (US News, 2013). Additionally, the US Bureau of Labor Statistics estimates an expected growth of 22% in the field for the period of 2010 – 2020 (US Bureau of Labor Statistics, 2011).

These are just a few of the recent reports to point out the continued need and demand for IT professionals.

The challenge faced by faculty in computer information systems is to design a curriculum that is relevant to the evolving needs of employers. Educators face a rapidly changing industry, highlighted by a dynamic environment where today's technology quickly becomes tomorrow's legacy system (Gallagher et. al. 2011). This can have a significant impact on

faculty who constantly try to cope with this environment by adjusting course content. There are resources available to aid faculty in designing curricula including the IS 2010 model curriculum (Topi et. al., 2010) and the ABET curriculum. However, these models often are limited as they have difficulty staying abreast of technological changes.

To make this challenge even more difficult, many business schools that are accredited by the AACSB (Association to Advance Collegiate Schools of Business) have restrictions placed on the number of courses required within the business school and often results in restrictions on the number of courses required in a major, such as information systems. (AACSB, 2013) Thus, IS (Information Systems) content in major courses must be designed efficiently in order to effectively cover the growing knowledge and skill set within limited course offerings. Knowing the relevant skills and technologies required by hiring employers can help to improve the overall curriculum within current IS programs.

Compounding the problem is rapid technological change which makes it even more important for IS curriculum to remain relevant to employer needs (Legier, Woodward, Martin, 2013). There are several problem areas for developers of IS programs that need to evolve as technology and industry needs change. These problem areas are:

- How to meet employer needs in the 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; and
- How to incorporate frequent advances in technology into the same number of courses

This research is a follow-up study of similar surveys conducted in 2003 and 2008 (*xx – reference will be added after review*). The goal is to report the current state of employer skill needs and also highlight changes in occupations and skills demanded by industry since the last employer survey.

It also offers a unique perspective in two ways. First, it attempts to “drill-down” to understand

the employer needs for an occupation. For example, it is helpful to identify the mix of knowledge and skills needed for database professionals, not just that a database course is necessary in the curriculum. Second, this survey was built from an employer perspective (of job skills needed) versus many surveys that are built from the academic side (what courses should be delivered).

2. LITERATURE REVIEW

There are numerous research efforts in the area of matching curriculum content to employer needs. These surveys generally revolve around two areas. The first matching technical skills and IT knowledge content needed to those taught. The second is more general and relates to the interpersonal skills today’s employers expect from IT professionals.

The needs surrounding IT content knowledge have been researched from a variety of perspectives. Richards et al. (2011) examine a specific IT role by evaluating the needs for Business Analysis skills by all IT graduates. Other researchers examine the broader demand for skills. Studies conducted by Woratscheck & Lenox (2002) and Cappel (2002) report that the top skill set desired by employers was systems development life cycle knowledge. Likewise, Medlin, Schneberger and Hunsinger (2007) completed a study of employers and found these skills in demand: Knowledge of standard software applications, ability to design user-friendly graphical interfaces, knowledge of programming languages, knowledge of databases, knowledge of networking and knowledge of computer hardware. Additionally, Janicki et.al (2008) reported that employers expected a working knowledge of system documentation, security, IT ethics and privacy, problem identification, specific programming language and process analysis.

The audience surveyed has also varied to include the perspective of different populations. For example, He and Guo (2011) interviewed IT recruiters who reported that database, spreadsheet, general IT skills and project management were their leading reasons for hiring IT professionals. Dilion and Kruck (2008) did a similar study of employer needs with a focus on Accounting IS and the needs for AIS graduates. Their survey reported a high degree of auditing, operating systems and database knowledge. Research conducted by Legier,

Woodward and Martin (2013) discuss the needs from the perspective of recent graduates as they entered and worked in the field.

Research in this area has not been limited to the examination of technical skills for professionals. For example Legier, Woodward and Martin (2013) detail the need for students to gain thinking and communication skills plus the desire to learn as the key components in their careers as IT professionals. This matches a previous study by Lee et al. (2002) where they rated interpersonal, team, and communication skills higher than technical knowledge and skill sets. Another recent study by Van Auken et al. (2011) also stressed the importance of communication skills in addition to possessing business acumen. Tesch et al. (2008) reinforce the need for additional interpersonal skills for all graduates

A study by Gallagher et al. (2011) summarizes much of the previous research in employee needs and curriculum needs by stating that "essential skills will remain a main focus of IT programs, improvements could be made in laying a foundation in non-technical skills" (p.9)

3. METHODOLOGY

To build on the results of previous research, we built our survey to provide a more detailed examination of the job skills and knowledge (technical and non-technical) needed for indicated current or anticipated "hot" jobs across both undergraduate and graduate degree students. We sought to answer three key questions:

- a) what are the technologies currently in use and projected to be in use in the near future by corporations?
- b) what are the IS skills required for specific jobs as well as IS skills are needed by all IT graduates?
- c) What is the projected demand for graduates by job category.

The survey instrument was developed in four phases as shown in Figure 1.

Phase One

During phase one, 25 professionals from various IT professions and responsibilities (members of a corporate advisory board, met with faculty to develop relevant job titles, areas and responsibilities important to IT professionals.

This advisory board consists of representatives from a variety of employers ranging from those with more than 500 employees down to employers with 20 or more employees.

Roundtable discussions occurred in which the group was given the job titles from the 2008 survey and asked to delete, modify and add titles to represent today's IT professionals. For example, the job titles of programmers, web developers and app developers were all consolidated into software developers. Changes from the previous surveys are noted at the end of Section 3.

A second task was to develop a detailed list of job skills necessary for particular job area. For example, the job skills for a database professional were considered to be knowledge of SQL, reporting services, normalization and fine tuning performance.

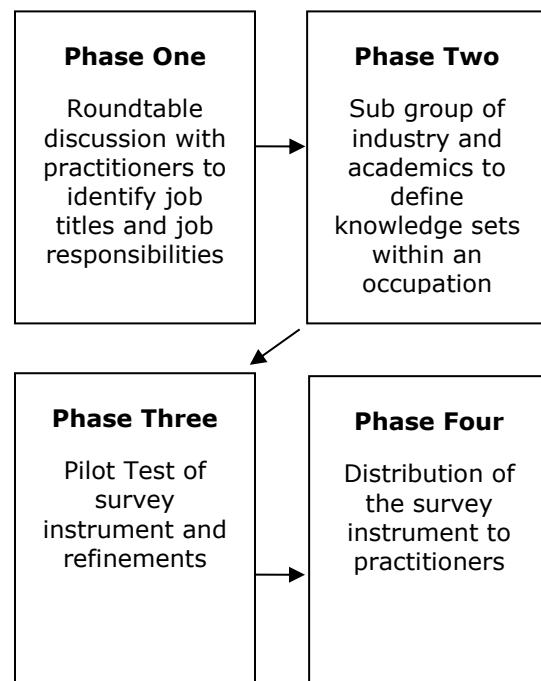


Figure 1: Survey Methodologies Stages

Phase Two

Working with academicians, a sub group of these professionals helped to define the job knowledge areas required for each occupation. These job categories went through several iterations and included pilot testing with other industry professionals to ensure the proper job skills were defined.

This resulted in the development of eight potential job categories as shown in Table 1.

Big Data / Data Analyst
Business / System Analyst
Database Admin/Analyst
IT Managers / Strategy Analyst
Networks / Security
Project Manager
Software Developer

Table 1:
Job Categories for IT Workers

To understand employer needs, the job categories shown in Table 1 were further defined into skills questions to help with course development. This provides a 'drill down' capability to enable faculty to design their syllabi around specific topics needed by industry.

To illustrate this 'drill down' by knowledge area, the following list details the sub category questions for the Business / System Analyst job category:

- Data Modeling
- Object Oriented Modeling
- Process Analysis
- Process Modeling
- Requirement Analysis
- Software as a Service Knowledge
- Structured Design
- System Design
- UML/Object Modeling
- Web Services

Respondents were asked to indicate the level of knowledge desired for each sub category as 'none, fundamental, working or expert'. To minimize the length of the survey, the respondents would only be asked 'sub category' questions for either their occupation or for one occupation they supervised.

During this phase, the survey instrument was also further developed. Questions were included to ask about general demographics (age, gender, location, company size, industry, job title) and if they were responsible for hiring or supervising IS/IT professionals. Based on the answer to the hiring/supervising questions, the survey would branch off to either Branch A (if they answered yes) or Branch B (if they answered no). Branch A was for participants who managed or hired IT professionals while Branch B was for those participants only working

in the field (not involved in managing or hiring). The following provides the question areas asked for each branch:

Branch A: Hired or Supervised IS/IT professionals:

- Anticipated Hiring for IT professionals in the next 24 months for jobs found in Table 1.
- Drill down skills needed for the job with the highest number of employees they supervised

Branch B: Worked as an IT professional

- Detailed expectations for the skills they should possess for their respective occupation
- Various technological knowledge areas expected for this occupation

Phase Three

A pilot study was conducted to ensure that the survey would be clear to the participants with an average completion rate of 5 minutes or less. The survey request was emailed to twenty five industry professionals who were directed to a web site to complete the survey. They were asked to record the time to complete the survey and to print any pages that were misleading and reply back with any suggestions. Fourteen of the twenty five requests were completed.

Following completion of this pilot test, the survey instrument was revised and ready for distribution.

Phase Four

The request to complete the survey was emailed to 3578 individuals in either the IS/IT field or those known to potentially hire IS/IT professionals. The distribution email came from three sources: a) the membership roster of the Association of Information Technology Professionals (AITP) members), b) 653 IT professionals that had attended at least one IT conference hosted by the university and c) 575 IT alumni from the institution. All information collected was confidential as no identifying information was gathered by the respondents.

3.1 Changes to Job Categories

It is interesting to note the changes to job categories from the last survey in 2008. From the industry professionals the following job titles

were dropped or consolidated prior to distribution of the 2013 survey:

- A consolidation of web developers, programmers and graphic design development was merged into software development
- Networks and Security which were two different categories was merged into one category as the need for security is needed for any network administrator was related by the industry professionals.

New job categories also appeared in the 2013 survey. These included:

- Big Data / Data Analysis
- Project Management was separated from overall IT Management and Strategy in previous surveys.

3.2 New Sub Category Questions

Within job categories major job responsibilities evolved for the 2013 survey. Shown are the key new job skills needed for today's IT professionals that were not in the previous surveys. These are not the only skills needed but the new ones added to the survey. These job skills should assist in course development.

Big Data / Big Data Analyst

- Analytic Tools (SSIS/SSAS/SSRS)
- NoSQL / Object Storage
- R Knowledge
- Raw, Unstructured Data
- SQL Query
- SQL Reporting

Business / System Analyst

- SaaS (Software as a Service)
- Web Services

Database Admin/Analyst

- Big Data Analytics
- Big Data Storage Concepts
- Data Cleansing / Integration
- SAN
- Virtualization

Network / Security

- BYOD (Bring Your Own Device)
- Cloud Computing
- Virtualization
- Wireless Admin

Software Development:

- Graphics / Visualization
- CSS 3
- HTML 5
- jQuery
- Mobile Device Development
- .Net MVC

4. SUMMARY STATISTICS

As stated the survey was emailed to 3578 IT professionals. 352 started the survey, and 225 completing all nine pages of the survey. This represents a 6.3% response rate. Of the over 100 professionals who started the survey, but did not complete all pages, 40% of them listed their job as 'Other IT' for which we did not ask any job detail questions beyond the first 4 pages of the survey.

The summary statistics presented represent those respondents who completed all pages of the survey. Overall, 49% of the respondents worked in corporations, while 19% worked for educational institutions. The remainder worked for government, sole proprietors or LLCs. The size of the organization varied from 24% working for companies with 100 to 499 employees while 25% and 21% worked for 1000+ and 10000+ employee firms respectively.

Women represented 20% of the survey respondents, with men comprising 80%. The education level varied for the respondents with 30% having a BS in an IT related field and 16% with a BS in a non IT related field. 19% had a master degree in IT while 16% had a master degree in a non IT master degree field.

The median number of years at their firm was 6 years, while the median number of years in the IT profession was 15.5 years. Interestingly, 30% of respondents held at least one certification. Popular certifications included:

- A+ (general technical certification)
- PMP (project management professional)
- CDP (certificate in data processing)
- CCP (certified computing professional)

As for various job categories, the respondents represented 8 different categories of IT/IS professionals. Their job categories and percentage of the overall respondents is shown in Table 2.

IT Management	16.8%
Software Development	16.8%
IT Strategy	14.6%
Networks/Security	9.3%
Business / System Analysis	8.4%
Project Management	7.5%
Database Admin/Analyst	4.9%
Big Data / Business Intelligence	2.2%
Other IT Jobs	19.5%

Table 2:
Job categories of Survey Respondents

More details on summary demographics may be found in Appendix A.

5. HIRING EXPECTATIONS INCLUDING NEW JOB CATEGORIES

To assist faculty in course development and students as they prepare for the job market, a section of the survey concerned future hiring expectations by position. Table 3 summarizes hiring expectations for 2013 and 2014 periods. The "Growth Rank" columns represent the number of employees expected to be hired in each category with 1 being the highest.

Job Categories	Total Current Employees Rank	Growth Rank	Growth Rank in 2008 Survey	Growth Rank in 2003 Survey
<i>Big Data / Analyst</i>	6	1	*	*
<i>Business / Systems Analyst</i>	3	3 (tie)	3	5
<i>Database Admin / Analyst</i>	7	3 (tie)	5	3
<i>Networks / Security</i>	5	5	2	2
<i>Project Management</i>	4	2	*	*
<i>Software Development</i>	2	6	1	1
<i>Other IT Skills (Primarily Help Desk)</i>	1	7	4	4

Table 3:
Occupations and hiring expectations for 2013 and 2014 periods
(*new category for 2013 Survey)

Table 3 details the responses from respondents who stated they were either responsible for hiring employees or supervising employees. These respondents reported supervising a total of 1119 employees in all of the categories. As shown in Table 3, Other IT Skills have the majority of IT professionals however it demonstrates the lowest growth job categories. Leading the new growth job categories for 2013 and also 2014 was Big Data Analysts. This growth rate is projected at 39% and 50% for 2013 and 2014 respectively. Another new job category in the 2013 survey was Project Management. This area details the second highest growth rate for IS/IT professionals. Project Management reported a growth rate of 32% and 27% in 2013 and 2014. Both of these job categories were not in previous surveys as they are relatively new job skills sets for IS/IT professionals. This is an interesting finding since only 2.2% and 7.5% of the current respondents worked in Big Data or the Project Management areas. Thus these areas and skills are seen to be increasingly important for future IT/IS professionals.

Dropping significantly was the projected demand for software developers. It was the highest demanded in previous surveys but it now rates as sixth place for job growth across all job categories surveyed. Even though it is in sixth place, the growth rate each year averaged 20%. Overall, survey respondents estimated a growth rate of 22% in 2013 and 21% in 2014.

Implications from the survey indicate that IS/IT programs should increase their emphasis of Big Data Concepts including storage, reporting and analysis along with additional Project Management concepts. Furthermore, IT managers will need to have foundation knowledge in these emerging areas.

6. TECHNICAL SKILLS DESIRED BY JOB CATEGORIES

Knowledge desired by occupation

The goal of the drill down by knowledge set is to help provide developers of curriculum an understanding of the current industry needs and to offer a wide range of knowledge sets in the curriculum.

Table 4 details the knowledge / technical skills reported for each IT/IS job categories. The top five skills for each job category are listed in

order of importance. Additional details on skills by job category may be found in Appendix B.

Desired Knowledge By Job Category	
Big Data Analyst	
	SQL Query
	SQL Reporting
	DB Design Concepts
	Tools (i.e. SSIS, SSAS, SSRS)
	Raw/Unstructured Data
Project Management	
	Team Management
	Resource Scheduling
	Risk Management
	Leadership
	Planning and Scheduling
Business System Analyst	
	Requirement Analysis
	Process Analysis
	Structured Design
	System Design
	Software as a Service (SaaS)
Database Admin/Analyst	
	SQL
	DB Programming (tie)
	Database Administration (tie)
	Data Cleansing / Integration
	Backup / Restore
Network / Security	
	Data Security
	TCP/IP
	Network Security
	Security Policies
	Desktop Support
Software Development	
	Data Structures
	Structured Programming
	Object Oriented Programming
	ASP.Net
	Design Patterns
Note: A breakdown of languages and platforms may be found in Appendix B	

Table 4: Desired knowledge for IT/IS Job Categories

Finally the survey asked what overall knowledge about IT/IS should all IT/IS professions possess. Table 5 details the level of overall IT knowledge

desired in order of importance. It should be noted that all of the knowledge categories were from the Fundamental Knowledge area, implying IT/IS professionals should possess basic knowledge of the concepts for the IT/IS categories.

Business / Systems Analysis
Project Management
Networks / Security
Database Skills
System Admin
Software Development
Data Analytics
Cloud/Virtualization

**Table 5:
Desired knowledge of IS/IT topics for a 'all
IT/IS professionals.
Scale: 1=None; 2=Fundamental;
3=Working; 4=Expert**

6. DISCUSSION

The IT/IS profession continues to evolve with ever increasing and changing skills and knowledge areas demanded for today's IT/IS professionals. The two new job categories that were added to the 2013 survey included both Big Data and Project Management. These areas were added at the recommendation of a corporate advisory board and the survey results indicate that both Big Data and Project Management positions will be the highest growth areas in the next two years. Implications for course curriculum indicate additional emphasis should be added for Big Data handling, storage, and analysis as well as increased concentration on Project Management topics.

Another change to the demand for IT/IS professionals from prior surveys was the reduction in emphasis on software developers. In the 2008 survey, software developers were projected as the highest growth area, while in 2013 they are reported as the sixth highest growth area. It should be noted, that although software developers were listed as the sixth highest growth area, the highest total of employees supervised were reported for the software development area. The growth rate was projected at 20% for software development even though it was ranked sixth.

The survey reported, in order of growth, the following areas as having the largest growth in positions: Big Data, Project Management,

Business / System Analyst, Database Analyst, Networks & Security and Software Developers, with all categories in double digit projected increases.

Within job categories, the skill set demanded by employers has also changed between 2008 and 2013. Several new skills emerged as topics that IT/IS professional should possess: Business Analysis, Database Analysis and Networking. These include skills such as SaaS for Business Analysts; Big Data Storage Concepts, SAN, and Data Cleansing for Database Analysts; and Cloud Computing, Virtualization and BYOD (Bring your Own Device) concepts for Network professionals. Again, the implication for courses is the need to constantly stay in touch with industry trends and adjust curriculum to match industry needs and new concepts.

For all IT/IS professionals, respondents indicated the need for IT/IS to possess business/system analysis skills. This was the highest overall skill required in previous surveys and indicates the need for students to understand problem solving, interviewing clients and developing solutions to problems involving technology. Project Management skills increased to second place as the survey indicated that all IT/IS professionals manage projects of varying sizes and need skills ranging from resource management to team leadership. Also added to the knowledge set from the 2008 survey was the need for fundamental knowledge of data analytics and cloud/virtualization concepts.

7. SUMMARY

Several new areas requiring curriculum attention arose from our survey which are Big Data Concepts including storage, reporting and analysis along with additional Project Management concepts. This is not limited to those working directly with the technology. IT managers in all areas of IT will need to have fundamental knowledge in these areas as well.

The 2010 Model Curriculum (Topi et al., 2010) does include a module for Project Management; however not present in the model curriculum is the growing field of Big Data Analysis. While there is a core course on Data Management currently in the curriculum model, it is more related to the building of relational database models. While the curriculum model sufficiently covers many of the skills needed, changes to

future models are needed for universities to effectively utilize the curriculum.

Also not present in the 2010 model curriculum are concepts or a course in software development. The survey results indicated growth rates in excess of 20% for these skills for future employees. Faculty responsible for curriculum development need to consider the inclusion of software development languages and principles in their course offerings.

In summary, the survey indicates the need for IT/IS academicians to stay current in the field. It is evident that it is increasingly difficult to add new concepts to the curriculum while maintaining the need for basic concepts in the areas of system analysis, database, networking, security and software development all remain strong. Especially difficult is to incorporate changes quickly into the model curriculum model.

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Editor's Note:

This paper was selected for inclusion in the journal as a ISECON 2013 Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2013.

APPENDIX A

Demographic Summary Tables

# of Employees	2013 (%)	2008 (%)
< 11	8.7	12.9
11 – 20	2.2	6.1
21-100	9.5	19.1
101-499	25.5	10.4
500-999	8.2	25.6
1000-9999	25.1	23.6
>10000	20.8	2.3

Table 6: Size of the organizations

Organization Type	2013 (%)	2008 (%)
Corporation	47.6	58.3
Education	20.8	10.0
LLC	8.2	8.4
Government	6.9	12.3
Healthcare	5.6	-
Sole Proprietor or Partnership	5.6	5.2
Non or Not for Profit	5.2	5.8

Table 7: Organization Type

Company Location	2013 (%)	2008 (%)
NC	40.7	50.2
IL	7.4	-
CA	6.9	1.8
WI	6.5	-
MO	3.9	-
SC	3.5	-
GA	3.0	-
NB	3.0	-
PA	1.3	16.5
OH	1.7	12.5
MI	.9	9.0
Others	21.6	11.0

Table 8: Company Location

APPENDIX B

Summary of knowledge areas expected for IT/IS Professionals by Job Category (Ranked in order of importance)

Big Data / Business Intelligence

Fundamental Knowledge

- SQL Query
- SQL Reporting
- DB Design Concepts
- Tools (SSIS, SSAS, SSRS)

Some/Minimal Knowledge

- Raw/Unstructured Data
- R Knowledge
- SPSS, SAS

Business / Systems Analyst

Fundamental Knowledge

- Requirements Analysis
- Process Analysis
- Structured Design
- System Design
- Software as a Service (SaaS)
- Object Oriented Design
- Process Modeling
- Data Modeling
- Web Services

Some/Minimal Knowledge

- UML/Object Modeling

Database Admin / Analyst

Fundamental Knowledge

- SQL
- DB Programming (tie)
- Database Administration(tie)
- Data Cleansing / Integration
- Backup/Restore
- Virtualization
- Data Modeling
- Performance Tuning

Some/Minimal Knowledge

- Data Warehousing
- Big Data Analytics
- SAN
- NAN

IT Management / IT Strategy

Fundamental Knowledge

- System Analysis
- IT Strategy
- Human Resources
- System Architecture
- Presentation Skills
- Ethics/Privacy Policies
- Team Leadership
- Project Management
- Supervisory Skills
- Negotiation Skills
- Vendor Relations

Network / Security

Fundamental Knowledge

- Data Security
- TCP/IP
- Network Security
- General Security Policies
- Desktop Support
- Network Admin
- Firewall Admin / Security
- Windows Admin
- Wireless Windows Admin
- Virtualization

Some/Minimal Knowledge

- Cloud Computing
- BYOD (Bring Your Own Device)
- Linux Admin
- Network Programming

Project Management

Fundamental Knowledge

- Team Management
- Resource Scheduling
- Risk Management
- Leadership
- Planning and Scheduling
- Project Management Software
- Inter-Organizational Relationships

Some/Minimal Knowledge

- Reporting Software

Software Development

General Development Concepts

- Data Structures
- Structured Programming
- Object Oriented Programming
- ASP.Net
- Design Patterns
- Algorithms
- User Interface Design
- Web Services
- Graphics/Visualization

Languages

- PHP
- HTML 5
- C#
- JavaScript
- XML
- ASP.Net MVC
- jQuery
- Java
- Python
- CSS 3
- C++
- JSP