Critical Skills for Computer Academicians Course Proposal

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Abstract

The numbers of Computer Science professionals are rapidly increasing in Pakistan. Earlier revisions of the CS curriculum made by Higher Education Commission (HEC), Pakistan were based upon the critical skills needed for the professionals according to the demands of market. Unfortunately no effort was made to determine the critical skills needed for computer academicians. As part of the course development process for academicians, a study was conducted to determine the expected skills and knowledge required for these academicians. The academicians are divided into three main groups: Computer Programming instructors, Databases Instructors and Computer Networks instructors. These groups were made after the survey of demand from IT industry in Pakistan. It was concluded from the survey that More than 65% Computer professional jobs are required for the mentioned groups. An online survey tool (http://www.qnaire.netfirms.com) was developed to collect the data from respondents about the importance of various skills for computer science academicians. Ph.D professors, Ph.D Assistant Professors and Lecturers having Bachelors degree in Computer Science or relevant discipline are included in the list of respondents. The results indicate that the conceptual knowledge about three groups will be important with handsome emphasis on advanced applications. By applying principal component analysis and correlation analysis on the data collected by online survey the prominent factors were identified on the basis of which a course plan was developed. In coming years the better results will produce by the proposed curriculum.

Keywords: curriculum development, computer academician, programming instructors, database instructors, networks instructors, teaching assistants.

Introduction

The number of workers in the computer software industry has been increased three times as compared to the past decade (Freeman & Aspray, 1999, p. 35). The skills that are needed to be successful in the field of Computer Science are constantly changing. The Researchers showed a lot of interest to find the gap between expected level of skills and observed level of skills once a person has been hired. Cappel's research showed that the development of programming skills remained an essential component for Computer professionals (Cappel, 2002, p. 76-82). Byrd research indicates that besides technical skills, managerial, business and interpersonal skills have also become increasingly cited for these professionals (Byrd & Turner, 2001 p.21-55). Liu focused on the technical skills necessary for entry-level professionals. Examination of Monster.com

and HotJobs.com technical skill requirements over a 10-week period revealed much greater demand for contemporary programming languages and Web-development skills and less demand for traditional programming skills (Liu, Kiu, Koong, & Lu,, 2003, pp.191-196). Hingorani and Sankar acquired student and industry perceptions of twenty skills required of new MIS (Management Information System) hires in the Information Systems industry. Results of a comparison of perceptions indicate that the student and the industry rankings differ. Students perceived "problem solving" as the number one skill of an IS professional, while the industry ranked it at six. Likewise, the industry ranked system analysis and design as the most important skill, while the students ranked it at number six. The broad skill of business communication and interpersonal relations was given a number two ranking by both the students and industry (Hingorani & Sankar, 1995). Gerald F. Braun identified critical skills for Computer Professionals after taking responses from Managers and IT professionals through an ASP based online survey tool. The survey measured entry level IT/IS skill expectations and employer satisfaction with knowledge/ skills possessed by recent hires. The curriculum which is necessary to train an academician so that these skills can efficiently be transferred to the graduates is addressed in this research (Braun, Tesch, & Skeldon, 2005).

Pakistan is one of the developing countries and Higher Education Commission in Pakistan has taken sound measures for advancement of higher education in the last five years. Computer Science is one of the major domains focused by HEC in this period.

Government of Pakistan, finalized IT policy in 2004 in which it was quoted that Human Resource (HR) Development is imperative for the local IT industry to upgrade the country as an important player in the international IT market. Under the HR Action Plan, a large pool of academically as well as technically skilled IT manpower would be developed to meet the local and export demands. The Policy accordingly envisaged the establishment of four new IT Universities, Virtual IT University, National Testing and Accreditation Services and Educational Intranet, strengthening of existing IT Institutes and hiring of Faculty from abroad. A major portion of the funds under IT Action Plan would be dedicated towards HR development initiatives (Ministry of Information Technology, Pakistan, 2004).

The software industry in Pakistan is not much advanced and relies on the use of old technologies and methodologies due to unavailability of the required professionals. There is a gap between the education provided to computer professionals and the needs of software industry.

Limbie Kelegai and Michael Middleton (2002) described that computer systems and software are rapidly becoming outdated, subsequently making an individual's knowledge quickly obsolete. Policy makers generally considered the education system as the vehicle by which IT professionals are trained and prepared to meet industry needs. Emphasis is now placed on educational system to produce IT professionals to meet the demands of the changing workplace. Third world countries have been slower in realizing the significance of human resources development, in particular for IT, in order to become a part of the global context. So it is the responsibility of the academician to guide the student about research and development and to adopt new technology in an efficient manner.

(IEEE-CS) and the Association for Computing Machinery (ACM) Computing Curricula 2001 (CC2001) consist of five volumes; Vol. 1 Overview, Vol. 2 Computer Science, Vol. 3 Computer Engineering, Vol. 4 Software Engineering, and Vol. 5 Information Systems in which abilities and skills essential for IT resource person are mentioned. It is advised to focus on following;

- Cognitive abilities and skills relating to intellectual tasks specific to computer science
- Practical skills relating to computer science

- Additional transferable skills that may be developed in the context of computer science but which are of a general nature and applicable in many other contexts as well.

Srinivasan, Guan, and Wright (1999) describe a process of developing a new curriculum working with corporate partners. They also suggest using the corporate partners as "clinical": faculty to help teach the courses. Trauth reported that the computer professionals in future would also be responsible to lead organizational IS for which they will need to have managerial, business operations and interpersonal skills along with technological skills (Trauth et.al, 1999). Maier Clark and Remington (1998) surveyed the job advertisements for a period of 15 years to explore the changes in IT job market. Maglitta in Computerworld reported that academicians and IS managers are dissatisfied with the technical, business, industry and soft skills of IS professionals. They criticized the knowledge of graduates on hot technologies like Telecommunications, RDBMS, project management, communication, documentation, e-commerce, business process reengineering and team skills (Maglitta, 1996). Cheryl L. Noll and Marilyn Wilkins (2002) fashioned a questionnaire including the questions of IS knowledge, programming, platforms/ operating systems applications, networking and database software, business functional knowledge and interpersonal and management skills. The importance of each skill was elicited from staffing groups in order to define a set of critical skills. Most of the rated critical skills in this research are extracted from the work of Cheryl L. Noll. Barbara J. Nicolai presented successful IT curriculum with accreditation point of view. This curriculum is very much suitable for identifying the needed skills of IT professionals (Nocolai, 2004). Stuart specified interest scales, aptitude and achievement tests as cognitive predictors of success in Computer programmer training. His research was hypothesized on the relationships between programmer trainee performance and inferential ability, programmer trainee performance and deductive ability, programmer trainee performance and interpretive ability, programmer trainee performance and general mathematics ability, programmer trainee performance and ability to recognize and apply the implied rules and basic assumptions (Jacobs, 1973).

Yongbeom Kim identified 30 key Information system issues after conducting a survey of IS practitioners and educators regarding the perceived importance. The survey results showed that the two groups perceive differently the relative importance of twelve IS issues, while they agree on the relative importance of the remaining eighteen IS issues. Based upon the results, Kim suggested specific guidelines for effective implementation of IS curriculum by attempting to bridge the gap between practitioner-educator perceptions of IS issues (Yongbeom, 1999).

These factors will be useful for preparing a preparatory course structure for computer academicians.

Higher Education Commission (HEC) Pakistan proposed detailed curriculum for BS (Computer Sciences) in 2004. The curriculum included core courses of 37 credit hours, supporting sciences of 12 credit hours and general education of 15 credit hours (2004). The detailed curriculum is available at http://www.hec.gov.pk. This curriculum was useful for getting information about focused studies in BS (Computing).

Ruth A. Miller and Donna W. Luse (2004) focused on communication and collaborative skills, which are critical for IS staff for system development.

Computer Skills growth chart is presented by Instructional Technology Guiding Rigorous Academic and Teaching Excellence (INTEGRATE) a working group of Delaware center for Educational Technology (DCET) (2005). The computer skills in this research are divided into five sections, Email & Internet, Network & computing skills, word processing, Graphics and databases. The critical skills for each section are identified separately.

A number of efforts have been made to highlight the guidelines needed for curriculum development or for identification of critical factors for the students of computer sciences. The skills which are critical for computer academicians can be derived from this literature. In this paper a study is reported, that was conducted to determine the critical skills for a computer academician. Computer academicians were divided into two groups: subject specialists and teaching assistants. The IT industry in Pakistan is in demand of Computer programmers, Database professionals and Network Engineers so this study was further focused to the subject specialists of these three areas. In particular these questions were addressed.

- What are the critical skills for subject specialists in the sub-domains of computer sciences?
- A pre-service course should be offered to subject specialists. How should this course be structured? The curriculum of course can be offered in extension of this work.
- What are the critical skills for teaching assistants?
- A pre-service course should be offered to teaching assistants. How should this course be prepared?

Research Methods

The literatures from the domain of Computer Sciences as well as recent research efforts made (as mentioned in the above section) are extensively researched to find out important factors with respect to academician as well as student point of view. We mentioned earlier about the gap between the education provided to computer professional and the needs of software industry as well as computer academia. To fill this gap, one way is to address the student curriculum which has been frequently changing for last three decades. Another way is to provide training to computer academicians who then teach the students as per normal accredited syllabus specifically focusing upon the key areas of these three domains i.e. Programming, Databases and Networking. The key areas with the associated weights will be specified later in the paper. An online questionnaire was prepared on the basis of literature review and interviews with professors, assistant professors, associate professors, lecturers from a number of IT-based universities in Pakistan, database managers, IT managers, senior software developers and System Analysts. The questionnaire was uploaded at free sub-domain (URL of questionnaire). An email was sent to all the respondents for requesting them to complete the online questionnaire. This email was also sent to the Chairman, National Computing Education Accreditation Council (NCEAC) Pakistan and other members of NCEAC. The questionnaire was sent to a total number of 180 academicians, 16 administrators, 20 members from concerned authorities working under Higher Education Commission (HEC) and 30 members from software industry. All the universities and graduate institutes in Pakistan took charter from HEC and secondly HEC is very much interested in improvement of graduate education in Pakistan for which they established accreditation council, quality assurance agencies and awarded scholarships to students as well as to various faculty members for acquiring technical and professional diplomas as well as degrees in the last few years (http://www.hec.gov.pk). So it was necessary to take the opinion of authorities of HEC before designing such a course for academicians. The online survey has mainly been targeted for academicians in education sector because the response for software/IT industry was not so appropriate. As the jobs or the work allocated to industry personnel is objective oriented so they were unable to comment on a broad domain of Computer sciences. Even, the questionnaire was divided into parts so that the database relevant questions should be responded by database professionals, programming relevant questions by programmers and so on. But the interviews revealed that they were not even able to respond questions from a broad domain of database management and computer programming due to limited scope of their job, very much specific set of responsibilities and lack of intellectual abilities. As a result, the responses from academic institutes were considered only for getting ap-

propriate results. Fifty five questionnaires were returned. The questionnaire was designed in such a way that all of the responses were usable aggregating 31% (approx) response rate. All of the PhD academicians responded in this regard was at the list of HEC recognized supervisors for PhD studies. A few of non-respondents experts were interviewed. Some respondents were also interviewed. This interview was based upon two grounds: accuracy of the designed questionnaire, questions listed in the questionnaire.

Design of Questionnaire

The questionnaire was designed in such a way that the respondent might feel it convenient to go through. All the questions were scaled on 1-10 scale in an objective manner, where 1 represented the least while 10 represented the most critical value. For example, "Importance of analytical Skills" is questioned to the respondents and the response was taken on a scale made with the help of radio buttons on webpage.

Where 1 means that the analytical skills are least critical. The increase in scale represents the increase in level of criticality, ending at 10, representing the highest critical value.

The questionnaire was divided in three sections.

- Critical Skills for Programming Instructors
- Critical Skills for Instructors of Databases
- Critical Skills for Instructors of Computer Networks

Results

First of all, following personal information about respondents was collected: Full Name, Designation, Qualification, University/Institute, Email address, Contact Number, age, experience, Areas of Expertise. (See Table 1.)

Some of sub-domains of Computer Sciences were included in the list of expertise which reflected that the participation of personnel from these sub-domains is more appreciable and useful. These sub-domains included Programming, Databases, Networks, Simulation & Data Modeling, Software Engineering, Electronics, Computer Engineering relevant, Theoretical Computations, Operating Systems, Algorithms, Planning Sciences, Business IT and Statistics on Data. Of the fifty five respondents, eighteen were Ph.D Professors/ Associate Professors/ Assistant Professors, twelve were non-Ph.D Professors/ Associate Professors/ Assistant Professors, thirteen were Lecturers and twelve were in non-teaching staff (administrators, HEC resource persons) in well-reputed universities and colleges in Pakistan. All of the included institutions enjoy a good reputation in computer education and are having the most competent and experienced faculty members. Higher Education Commission in Pakistan ranked these universities/colleges in Class "A" which contain resource-wise rich institutions (2004). The criteria for evaluation of these universities/institutions before adding them to a specific class, is uploaded on the website of HEC (http://www.hec.gov.pk). The faculties of university/institution bear good weight- age in the mentioned criterion.

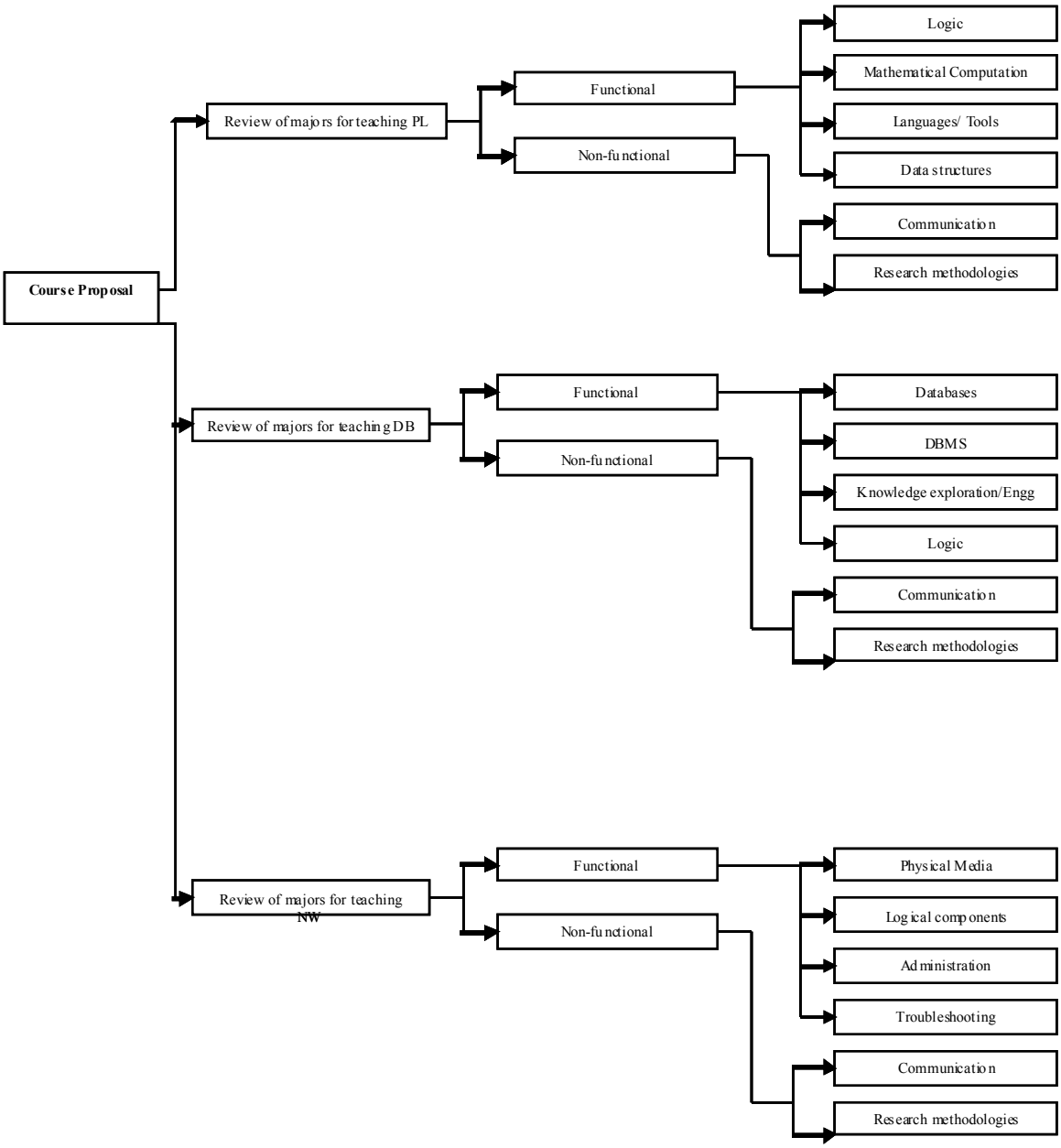

Figure 1- Critical skill evaluation model

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS		
SEX		
TOTAL	MALE	FEMALE
55	52	3
AGE: Mean: 37.5	Standard Deviation: 8.3	
EXPERIENCE: Mean: 12.4	Standard Deviation: 5.7	
DOMAIN-WISE		
Programming	5	
Databases	8	
Networks	3	
Simulation & Data Modeling	2	
Software Engg	7	
Electronics	2	
Computer Engg	3	
Theoretical computations	1	
Operating systems	4	
Algorithms	1	
Planning Sciences	1	
Business IT	2	
Statistics on data	4	

The results extracted from various academicians are analyzed through SPP (software developed for prediction) to extract the principal components of acquired data. In short the data is analyzed with the help of principal component analysis by taking mean value of frequency of each skill mentioned by academicians. This value is subtracted from individual frequencies. The covariance matrix is designed on the basis of extracted covariance. Since, the covariance matrix was a square matrix so the eigenvalue and eigenvectors are identified before extracting principal components. The detailed step-by-step elaboration of principal component analysis is available in a tutorial by Lindsay I. Smith (Lindsay, 2002).

After extracting the principal components, critical value for each of the principal component was evaluated. Those values were considered to be critical where the variance of eigenvalue was greater than or equal to 0.70. The factors are ranked on the basis of these values. Table 2 depicts the critical values of skills.

Table 2. Skills with their level of criticality		
S.No	**Skill**	**Critical Value**
Programming Instructors		
1.	Skills of Commercial Programming	0.692
2.	Mathematical Computations	**0.842**
3.	Analytical Skills	0.680
4.	Spoken Language Skills	0.238
5.	Knowledge of Data Structures and mapping	**0.822**
6.	Pseudo code development	**0.802**
7.	Concepts of Language compilers/ Interpreters/ Assemblers	0.550
8.	Historical evolution of different programming languages	0.524
9.	Knowledge of Programming constructs	**0.888**

10.	Knowledge of Requirement elicitation	**0.702**
11.	Knowledge of program testing under various factors	0.664
12.	Theory of automata (Implementation point of view)	0.564
13.	Limitations of programming languages	0.420
14.	Comprehension skills	0.544
15.	Skills to evaluate and reduce the complexity of program unit	0.590
16.	Cost and benefit analysis of programming language	0.662
17.	Comparative study of programming languages	0.582
Database Instructors		
18.	Skills and knowledge of databases	**0.962**
19.	Knowledge of database management systems	**0.884**
20.	Commercial programming skills in databases	**0.725**
21.	Commercial programming skill for development of front-end applications of databases	0.480
22.	Commercial and non-commercial skills of database administration	0.586
23.	Command over distributed databases	0.642
24.	Skills of exploration of knowledge from databases	0.442
25.	Practical knowledge about behavior of various DBMS (RDBMS, ORDBMS)	**0.764**
26.	Analytical Skills	0.500
27.	Spoken Language Skills	0.390
28.	Knowledge of specific database query language	0.684
29.	Knowledge of Web Engineering on databases	**0.750**
30.	Knowledge of diagrammatic representation of relations within databases	**0.880**
31.	Knowledge of replication in databases	0.568
32.	Knowledge of File systems in comparison with databases	0.472
33.	Theoretical and practical skills on intelligent databases	0.640
34.	Knowledge about spatial databases	0.444
35.	Research oriented methodologies	0.448
Computer Networks Instructors		
36.	Knowledge of physical media involved in Computer Networks	0.575
37.	Knowledge of Network topologies	0.648
38.	Knowledge of standards defined in Computer Networks	**0.826**
39.	Knowledge of Analog and digital signal processing	**0.800**
40.	Knowledge of Data communication terminologies	**0.754**
41.	Knowledge of Operating systems involved in Networks at application level	**0.728**
42.	Knowledge of operating systems involved in networks at system level	0.546
43.	Knowledge of Network configurations	**0.700**
44.	Knowledge of directory/user services in Networks	**0.848**
45.	Troubleshooting in Networks	**0.902**
46.	Knowledge of MAN/WAN configurations	0.532
47.	Useful applications after installations and orientation of Networks	0.322
48.	Practical network establishment	0.556
49.	Network administration	**0.886**
50.	Spoken Language skills	0.542

51.	Comparative study of various networks	0.442
52.	Network algorithms	**0.892**
53.	Network programming	**0.844**
54.	Protocols in Computer Networks	0.684

The boldface values in the Table 2 are showing that the factors are critical according to the selected threshold. There were a few values quite near to the threshold so those values were also kept in mind during the development of curriculum but they are not ranked as critical.

The critical skills for computer academicians had been identified on the basis of obtained results. After the identification of skills, three different courses are proposed for academicians of Computer Programming, Databases and Computer Networks respectively. The personnel in Pakistani educational institutions are hired on two different merit criteria: (1). Specialist of the particular domain, (2). Teaching Assistants.

The three proposed courses are quite appropriate for specialists of domains but there should be a generic training course for teaching assistants who are expected to be skillful in a broad domain.

Course Structure for Subject Specialists

On the basis of critical factors extracted from the obtained results presented in Table 2, the following topics are included in the course offered to Subject Specialists (Professors/ Assistant professors) of Computer Programming.

First column in Table 3 shows the critical skills needed for specific subject area and second column propose the subject courses from which special topics can be selected for preparing the curriculum of the course.

In Table 3:

h.o.p = hands on practice session (practical work/ laboratory work)

p.w = project work

c.w = course work (theoretical)

Table 3. Proposal of Subject against each critical skill

Critical Skill	Special topics from	Duration = 48 weeks	
Computer Programming			
Mathematical/Logical computations	Discrete Mathematics (c.w = 10 hours), Logic & computation (c.w = 20 hours), Statistical computations (c.w = 10 hours + h.o.p = 5 hours)	3 weeks	45 hours
Data Structures & its mapping in memory	Data structures (c.w = 20 hours + h.o.p. = 5 hours + p.w = 10 hours) Logic & Computation (c.w = 10 hours)	3 weeks	45 hours

Pseudo Code development	Algorithms (c.w = 10 hours) Data Structures (c.w = 5 hours) Analysis of Algorithms (c.w = 10 hours + h.o.p. = 5 hours)	2 weeks	30 hours
Programming Constructs	Theory of programming languages (c.w = 5 hours) Object-oriented programming (c.w = 10 hours + h.o.p = 5 hours + p.w = 10 hours) ** Project should be done from both OOP and RA Rapid applications (c.w = 5 hours + h.o.p = 15 hours)	3 weeks	45 hours
Miscellaneous	Theory of computation (c.w = 10 hours) Theory of automata (c.w = 10 hours) Problem areas in Computer Sciences (c.w = 10 hours)	2 weeks	30 hours
Databases			
General Databases	Introduction to databases (c.w = 5 hours + h.o.p = 10 hours) Database models (c.w = 5 hours) Types of databases (c.w = 10 hours)	2 weeks	30 hours
DBMS	General concepts (c.w = 5 hours) Relationships (c.w = 5 hours) Administration (c.w = 5 hours + h.o.p = 10 hours + p.w = 5 hours)	2 weeks	30 hours
Commercial programming	SQL (c.w = 5 hours + h.o.p = 10 hours) SQL Server (c.w = 5 hours + h.o.p = 10 hours) MySQL (h.o.p = 10 hours) ERWIN (c.w = 2 hours + h.o.p = 3 hours)	3 weeks	45 hours

Behavior of different DBMS's (RDBMS, ORDBMS)	Database management systems (c.w = 5 hours + h.o.p = 10 hours) Object-Oriented databases (c.w = 5 hours + h.o.p = 5 hours) Data modeling (c.w = 5 hours)	2 weeks	30 hours
Web Engineering on Databases	Databases on web (c.w = 10 hours + h.o.p=10 hours) Online interactive database management (c.w = 10 hours + h.o.p = 5 hours + p.w = 10 hours)	3 weeks	45 hours
Diagrammatic representation of relations in databases	Entity-relationships (c.w = 5 hours) ERWIN, VISIO (h.o.p = 5 + 5 hours)	1 week	15 hours
Miscellaneous	Performance tuning and recovery of databases (c.w = 10 hours + h.o.p = 5 hours) Federated database management systems (c.w = 5 hours + h.o.p = 5 hours + p.w = 5 hours)	2 weeks	30 hours
Computer Networks			
Defined standards in Computer Networks	IEEE standards (c.w = 5 hours) Ethernet (c.w = 10 hours + p.w = 5 hours) FDDI standards (c.w = 5 hours) OSI standards (c.w =10 hours + h.o.p = 10 hours)	3 weeks	45 hours
Analog & Digital signal processing	Digital signal processing (c.w = 10 hours + p.w = 5 hours) Analog signal processing (c.w = 10 hours + p.w = 5 hours)	2 weeks	30 hours
Data communication	Computer Networks (c.w = 15 hours + h.o.p = 15 hours + p.w = 5 hours) Data communication standards and methodologies (c.w = 10 hours)	3 weeks	45 hours

Knowledge of Operating systems	Modern Operating systems concepts (c.w = 10 hours) Applications of Operating systems (h.o.p = 5 hours) Guide to operating systems (LINUX) (c.w = 5 hours + h.o.p = 10 hours)	2 weeks	30 hours
Network configurations	Network structures and configurations (c.w =5 hours) Networking Essentials (c.w = 5 hours + h.o.p = 5 hours)	1 week	15 hours
Directory/User services	Microsoft windows 2000 server and professional (h.o.p = 15 +15 hours)	2 weeks	30 hours
Troubleshooting	Microsoft windows 2000 server and professional, MCSE guide (h.o.p = 8 + 7 hours)	1 weeks	15 hours
Administration	LAN administration (h.o.p = 5 hours) Microsoft windows 2000 server and professional (h.o.p = 5 + 5 hours)	1 week	15 hours
Network algorithms	Algorithms for Computer Networks (c.w = 5 hours + h.o.p = 5 hours + p.w = 10 hours) Network system development (c.w = 5 hours + h.o.p = 5 hours)	2 weeks	30 hours
Network programming	Guide to Computer Network programming, Socket programming (c.w = 5 hours + h.o.p = 5 hours) JAVA as network programming language (c.w = 5 hours + h.o.p = 5 hours + p.w = 10 hours)	2 weeks	30 hours

The work can be extended to include full-fledge curriculum on the grounds of above-mentioned structure. This course structure will work for the subject specialists while most of the staff at undergraduate level and teaching assistants needs to have the integrated skills in all three subdomains. So there should be a separate preparatory course for the staff employed at this level.

Course Structure for Teaching Assistants

To prepare course structure for these teaching assistants following methodology is devised.

The websites, course brochures and interviews with dean/head of departments of various well-reputed IT/Engineering based institutions and HEC literature review and curriculum proposed by Higher Education Commission in 2004 made it possible to inference the following facts.

- Higher Education Commission Pakistan made four classes of subjects in BS program of computing.
    - These classes are Core Subjects, Elective Subjects, university electives and supporting areas.
    - Core subjects included; Computing, Programming Fundamentals, Object Oriented Programming, Data Structures & Algorithms, Discrete structures, Database systems, Digital Logic & Design, Operating Systems, Communication & Networks, Software Project Design.
    - It has been observed that 82.5% well-reputed and HEC recognized universities/institutions included Computing, Programming Fundamentals, and Object Oriented Programming, Digital Logic & Design, Operating Systems and Data structures as core subjects in the curriculum of BS in Computer Sciences.
- Computer Sciences Accreditation Commission of Computing Sciences Accreditation Board (CSAC/CSAB) (2000) designed curriculum for Computer Sciences in which 40 hours for Computer subjects, 30 hours for Mathematics & Science and 30 hours for humanities, social sciences and other disciplines were included. 62% universities/ Institutions in Pakistan follow the similar convention (Division of weight age in hours is different).
- William Burkett constructed a workable Computer Sciences curriculum (2002) in which he identified general characteristics of Computer Sciences graduates. These characteristics are;
    - System-level perspective
    - Appreciation of the interplay between theory and practice
    - Familiarity with common themes
    - Significant project experience
    - Adaptability
- The education in Computer Sciences needs more attention because of its fast growth. The rapidly changing technology in IT world make the skills of IT professionals obsolete after certain period of time. These professionals should be skillful in research methodologies to adopt the changing scenario in an efficient manner. So it had also been concluded that the computer academicians should have the ability to make the students well aware of research methodologies and of adaptability to the advancements in technology.

The mentioned conclusions and the survey through online questionnaire derived the critical skills for teaching assistants shown in Table 4.

Table 4. Proposal of Subject against each critical skill (TA)			
Critical Skill	**Special topics from**	**Duration = 38 weeks**	
Programming Skills	Discrete Mathematics (c.w = 10 hours), Logic & computation (c.w = 20 hours), Statistical computations (c.w = 10 hours + h.o.p = 5 hours)	3 weeks	45 hours
Data Structures & its mapping in memory	Data structures (c.w = 15 hours + h.o.p. = 5 hours + p.w = 10 hours)	2 weeks	30 hours
Programming Constructs	Theory of programming languages (c.w = 10 hours) Programming in C/C++ (c.w = 10 hours + h.o.p = 15 hours + p.w = 10 hours)	3 weeks	45 hours
General Databases	General concepts of Databases (c.w = 5 hours + h.o.p = 10 hours) Types of databases (c.w = 10 hours + h.o.p = 5 hours)	2 weeks	30 hours
DBMS	Database management and administration (c.w = 15 hours + h.o.p = 15 hours + p.w = 15 hours)	3 weeks	45 hours
Practical experience in query and development tools	SQL (h.o.p = 15 hours) SQL Server (h.o.p = 15 hours) MS ACCESS (h.o.p = 15 hours)	3 weeks	45 hours
Computer Operations	Computer Architecture (c.w = 10 hours +h.o.p = 10 hours) Digital Logic & Design (c.w = 10 hours + h.o.p = 5 hours + p.w = 10 hours)	3 weeks	45 hours
Database Models including diagrammatic representation	ERWIN (h.o.p = 5 hours) Relationships in Databases (c.w = 5 hours + h.o.p = 5 hours)	1 week	15 hours
Networking Essentials	MCSE guide for Computer Networks (c.w =10 hours + h.o.p = 20 hours)	2 weeks	30 hours

Networks establishments	Microsoft windows 2000 server and professional (h.o.p = 15 + 15 hours)	2 weeks	30 hours
Research Methodologies	Research Methods (c.w = 10 hours + p.w = 10 hours) Adopting new technology (c.w = 10 hours)	2 weeks	30 hours
Computer Electronics	Digital fundamentals for computer systems (c.w = 10 hours + h.o.p = 5 hours) Digital Logic & Design (c.w = 10 hours + h.o.p = 5 hours)	2 weeks	30 hours
Mathematics	Discrete mathematics (c.w = 10 hours) Calculus (c.w = 10 hours) Business mathematics (c.w = 10 hours)	2 weeks	30 hours
Business Education	Business communication (c.w = 10 hours) Accounting (c.w = 10 hours) IT in business (c.w = 10 hours)	2 weeks	30 hours
Software applied processing	Software Engineering (c.w = 10 hours + p.w = 5 hours) SAD (c.w = 10 hours + p.w = 5 hours) SAP (c.w = 5 hours + h.o.p = 10 hours)	3 weeks	45 hours
Project	Proposal and Thesis (p.w = 45 hours)	3 weeks	45 hours

Conclusions

The research identified and verified the critical skills for Computer academicians. For subject specialists, more emphasis should be placed on conceptual knowledge while the teaching assistants need fundamental conceptual as well as practical knowledge of the domain.

Computer Programming, Database development and Computer Networks are the three rapidly growing areas for Computer professionals in IT industry of Pakistan so the academicians need research and development skills in these three areas. The skills with highest critical values are knowledge of programming constructs and mathematical computations for programming instructors, skills/knowledge of databases and DBMS for Database instructors and Network trouble-

shooting, administration and algorithms for computer Networks instructors. The work can be extended to include full fledge curriculum for the proposed course which should be quite specific and domain-focused.

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