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Designing an IT Curriculum: The Results of the First CITC Conference

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Abstract

The CITC (Conference on Information Technology Curriculum) in December 2001 included representatives from 15 Information Technology (IT) programs at four-year schools in the United States. Also in attendance were representatives from the Association for Computing Machinery (ACM), the Institute for Electrical and Electronic Engineers (IEEE), and the Accreditation Board for Engineering and Technology (ABET). The purpose of this conference was to discuss many important topics in IT education, including a discussion of what constitutes an IT curriculum.

Because of the wide representation at the CITC, it is felt that the outcome of this curriculum discussion is of wide interest to all those in related programs or at institutions considering forming a similar program. This paper discusses the details of the results of the curriculum discussion, how decisions were made, and what the proposed curriculum includes and does not include.

Introduction

In the first week of December of 2001 representatives from 15 undergraduate Information Technology (IT) programs from colleges/universities across the country (see appendix), gathered together in Aspen Grove, Utah, to develop a community and begin to establish academic standards for this rapidly growing discipline. The Conference on Information Technology Curriculum (CITC) was also attended by representatives from two professional societies, the Association for Computing Machine (ACM) and the Institute of Electrical and Electronics Engineers, Inc. (IEEE), and also the Accreditation Board for Engineering and Technology, Inc. (ABET). This invitational conference was the culmination of an effort begun several months earlier by five of these universities who had formed a steering committee to organize a response from existing IT programs to several initiatives to define the academic discipline of IT. The steering committee wanted to ensure that the input of existing programs played a significant role in the definition of the field.

There are several efforts underway. The Technology Accreditation Commission of ABET (TAC-ABET) has proposed guidelines for Information Engineering Technology and the Computing Accreditation Commission (CAC-ABET) was discussing the relevance of its initiatives to this area. The TAC-ABET proposal concentrated on a narrow segment of the field as we saw it, while the CAC-ABET initiative, although they are working on accreditation standards for Information Systems (IS), was in only in the early stages of discussion. ACM and Computing Research Associates (CRA) formed a board of “IT” deans in 2000 [3] that meets twice a year working to define the underlying principles and relevant body of research, and that same year Peter Denning led a team that developed a model curriculum for an IT college [2]. The time was propitious for programs teaching IT to participate in developing the criteria that defined the discipline.

The usual approach to developing a new academic program in an established discipline is to review the existing body of knowledge and practice to establish the content and boundaries of the curriculum; but when there is no established discipline, the initial development tends to originate out of related academic disciplines and the research and collaborative efforts of teaching professionals. This initial stage naturally produces numerous interpretations of a model curriculum. During the 90s information technology programs developed out of CS, IS, MIS and Engineering. The influence of their origins can be seen in the design and content of the curriculum. Programs at Rensselaer Polytechnic Institute (RPI) and Georgia Southern University have a multidisciplinary approach that includes a strong IT technology core with a required sequence in an application area while programs at Rochester Institute of Technology (RIT), Purdue and Brigham Young University (BYU) focus on a strong technology core and provide the option to pursue an application area. At the present time even the term Information Technology is interpreted differently by many in academia and industry.

The development of IT as an academic discipline is similar to the process that Computer Science (CS) went through in the 70's and 80's. In fact, looking at the placement of Computer Science programs in academic institutions around the U.S. illustrates the debate that swirled around the discipline as its core was being defined. Some CS programs are in departments of Mathematics, others are in Engineering schools, and many others have become freestanding programs within newly emerging colleges of computing.

Information Technology, as it is practiced at this moment in its evolution, reflects similar growing pains. The participants in the Utah conference, while all believing they represent the discipline, brought a perspective shaped by their roots within their institutions and the backgrounds of their faculty. After all, none of the faculty who participated has a degree in Information Technology. The authors of this paper, for example, have graduate degrees from the disciplines of Engineering, Computer Science, Economics and Instructional Technology. We quite naturally bring our discipline's approach to problems, methodologies and temperaments to the new discipline. In fact, many of our participants felt obligated to represent faculty with even greater diversity of backgrounds. Guidelines that establish the standards and professional practices need to recognize the breadth and strength of existing programs and provide flexibility to build on the strengths and resources at their institutions.

Procedure

What is Information Technology? What are the core requirements of Information Technology? The participants at the CITC meeting engaged in an exercise to begin the process of defining IT as an academic discipline based on their collective experience. We believe that capturing the aggregate experience of IT programs represents one of the best ways to begin.

The biggest question that first needed to be answered was, “How can you appropriately and effectively receive input from 40 or more people, each with much experience and strong opinions on what needs to be a part of of an Information Technology (IT) curriculum?" Two of the authors had experience with a method that had been used at a conference they attended, so they tried it with their Industry Advisory Board in October of 2001. The results were very promising, so with further refinement, it was used at the Aspen Grove CITC conference.

Each participant was issued a pad of self-adhesive sticky notes and a blunt felt-tip marker. Then the entire group was given 20 minutes to generate as many topics as they could, one topic per sticky note. As each participant created a small pile of topics, they were encouraged to spread them out on several tables that were at the front of the room. This way, each participant could see ideas from other participants, further spurring ideas of their own. At the end of the 20 minutes, everyone had pretty well exhausted their ideas, and nearly 700 sticky notes had ideas for topics in an IT curriculum.

The second stage of the exercise was an unconstrained organization of the topics into groups. All attendees participated in moving the notes into groups, and after about 30 more minutes, essentially everyone agreed that all notes in each group belonged there. After this was completed, the sticky notes were gathered in their groups, and a spreadsheet was filled out with one column for each group.

This first cut at defining a curriculum left a few rough edges, as some notes were clearly mis-classified, and others were not optimally classified. Further scrutiny found some identical notes in separate groups, and other closely-related notes scattered about. Careful editing of each group reduced the entire output to 34 topic areas. Some of the topic areas were later found to be so closely related as to be basically inseparable, so they were combined. Looking through the subtopics may suggest other groupings.

At the conclusion of this editing work (about 2 weeks after the conference), the entire edited spreadsheet was sent to all conference attendees via email, and further feedback was sought and incorporated.

Results

The results of this exercise were very significant in several ways: 1) representatives from 15 universities with 4-year IT programs had participated - this represents a significant portion of the programs in the nation; 2) representatives from three professional organizations were also in attendance – these were three of the most relevant; and 3) each representative had ample opportunity to share all their thoughts, both as to topics and as to organization.

Table 1 presents an overview of the results. There are 28 topical areas in this overview, shown in the table in the order of how often they were mentioned (# represents the number of sticky notes mentioning this topic area).

Note that care must be used in interpreting the importance of a large number of sticky notes. If a particular topic had been listed (e.g. Physics) and the note had been seen, other people would not generate duplicates. Many citations indicates that people felt variations on the topic were important.

Several of these topic areas had so many sticky notes that, for the purposes of this paper, they need further clarification. Tables 2-11 give the sub-topics most often mentioned in these topic areas, along with the number of times they were mentioned.

Topic Area	#
Networking	109
Human communications	56
Software	52
Web system design	48
Database	44
Project management	36
Digital communications	35
Data security/privacy	33
Math	31
Systems design	28
Hardware: architecture & circuits	25
Human-computer interfacing	24
User advocacy	24
Thinking/problem solving	21
Teamwork	20
Enterprise topics	18
Ethics	17
Embedded systems	10
Holistic	10
Information content	9
Social factors	9
System administration	8
General education	6
Evaluation	5
Physics	4
Graphics	3
Co-ops	2

Table 1: Topic areas in an IT curriculum

Networking Sub-topic	#
Protocols	16
Fundamentals	9
Administration	5
Design	5
Routing	5
Switching	4
Operating systems	3
Topologies	3
Standards	2
Subnetting	2

Table 2: Sub-topics for the Networking topic area.

Human Communications Sub-topics	#
Presentation skills	12
Writing skills	12
Inter-personal communication	6
Technical writing	6
Documentation	4
Research skills	3
Cultural awareness & integration	2
Organizational culture & learning	2

Table 3: Sub-topics for the Human Communications topic area.

Software Sub-topics	#
High-level languages	16
Object-oriented programming	7
Basic programming concepts	6
Software engineering	5
Algorithm analysis & development	3
Application development	3
Assembly language programming	3

Table 4: Sub-topics for the Software topic area.

Web Systems Design Sub-topics	#
Application design & development	8
XML	5
HTML	4
Website design	4
Interface	3
Programming	2
User support	2
Web technologies	2
Website management & security	2

Table 5: Sub-topics for the Web Systems Design topic area.

Database Sub-topics	#
Database design	9
Basic database concepts	8
Database programming	5
Data modeling objects/UML	4
Data mining	3
Data warehousing	3
Database management	2

Table 6: Sub-topics for the Database topic area.

Project Management Sub-topics	#
Project management	7
Business fundamentals	4
E-business	2
Economics of IT at multiple levels	2
Leadership	2
Organizational structure	2

Table 7: Sub-topics for the Project Management topic area.

Digital Communications Sub-topics	#
Convergence of TV/Internet/phone	4
Wireless standards	4
Data communications	2

Table 8: Sub-topics for the Digital Communications topic area.

Data Security/Privacy Sub-topics	#
Data, web & network security	9
Privacy	4
Encryption	3
Identification & authentication	2
Information assurance	2
Viruses, worms, Trojan horses	2

Table 9: Sub-topics for the Data Security/Privacy topic area.

Math Sub-topics	#
Discrete math	9
Statistics	5
Probability	4
Algebra	2
Number systems	2
Set theory	2

Table 10: Sub-topics for the Math topic area.

Systems Design Sub-topics	#
Design & development	5
Analysis	4
Integration	3
Administration	2
Hardware/software integration	2

Table 11: Sub-topics for the Systems Design topic area.

As can be seen in Table 2, there were only 10 sub-topics which received multiple mentions; it means that there were many other sub-topics mentioned (55 in this case), but they were considered minor topics due to their infrequent mention.

The remaining topic areas had several sub-topics also, but essentially none with multiple mentions. However, further clarification is in order for most of them. The topic area of Hardware: architecture & circuits included such sub-topics as computer hardware and architecture, computer storage, and hardware fundamentals. The topic area of User advocacy included the sub-topics of user need identification and analysis, system life cycles, application integration, and seeing things from the user's perspective.

The topic area of Enterprise topics included enterprise resource planning, outsourcing, advanced word processing and spreadsheets, and software acquisition as sub-topics. Embedded systems included the sub-topics of device drivers and real-time programming. The Holistic topic area included such sub-topics as commitment to life-long learning, creativity, perseverance, and quality.

Information content, as a topic area, consisted of the sub-topics of information design, manipulation, retrieval and analysis, rich media, and content versus presentation. The topic area of Social factors included the issues of the digital divide, needs analysis, and drawbacks to IT solutions.

General Education	#	Related Courses	#	Professional Courses	#	Core Courses	#
Math	31	Hardware: arch. & cir.	25	Human communications	56	Networking	109
Holistic	10	Thinking/prob. solv.	21	Project management	36	Software	52
General education	6	Embedded systems	10	Teamwork	20	Web systems design	48
Physics	4	Information content	9	Enterprise topics	18	Database	44
		System administration	8	Ethics	17	Digital communication	35
		Evaluation	5	Social factors	9	Data security/privacy	33
		Graphics	2	Co-ops	2	Systems design	28
						Human-comp. interface	24
						User advocacy	24

Table 12: Organizing the main topic areas into four categories of course offering

Another way to look at the results of this exercise is to organize the topic areas into four categories typical in most curricula: General education, Related courses, Professional courses, and Core courses. Table 12 gives one way of doing this.

As shown in Table 12, there is a great deal of interest in educating the whole person. This is evident by noting the presence of and high numbers in topic areas such as Human communications, Teamwork, Enterprise topics, Ethics, Thinking/problem solving, and Holistic.

Table 12 also gives some powerful insight into one way of defining an IT curriculum for all IT programs across the nation. The strong number of mentions for the Core Courses indicates to these authors that all IT programs should consist of at least one course in each of these areas. It is these topics, in combination, that define the domain of Information Technology.

After the common core, IT programs could select from the Professional Courses and Related Courses to give their program the unique emphasis they feel is most important for their customers. This would give many strong IT programs across the country, each with a common IT core and an additional focus or flavor unique to each institution.

Most university majors also have sub-specializations within the major. Table 12 can also be used to help define these possible emphases for each IT program.

Finally, Table 12 shows that there is a strong need for a math foundation, particularly in algebra and discrete math. Also, depending on the institutional flavor, there may be a need for a course in physics.

Analysis

Having seen some of the results of this exercise, and one or two first cuts at how this might inform the design of a curriculum, let's step back for a moment and view it again from a distance. This is a report from the field of an effort by existing IT programs from varied academic institutions desiring to define an IT curriculum and establish standards that reflect their collective vision.

There was great diversity evident at the conference. However, we believe that rather than represent a problem, the diversity and complexity of the programs represented validates the results of our exercise. We feel that this exercise, despite its informality, presented a snapshot of the discipline both as taught and practiced at this moment. What is remarkable about the results of our exercise is the high degree of overlap and consensus. There certainly isn't unanimity yet about all the details of the curriculum, but it was reassuring to find that the view of IT from the diverse programs at the first CITC conference has so many common areas.

This exercise generated a list of topics, a productive start in developing a curriculum and a necessary first step. In the process of establishing an IT curriculum, we will probably want to move to a more behavioral approach to specifying learning that lends itself to assessment such as the specification of learning outcomes. It is possible that some degree of cohesiveness experienced in this exercise may loosen as learning outcomes clarify the meaning of topics, but an IT curriculum is likely to be moving target and in need of frequent re-evaluation under any circumstances.

Given the diversity of academic programs across the nation, it is not desirable to achieve one comprehensive curriculum. But given the degree of consensus reached during our exercise, recommendations for a common core and general guidelines for other elements of the curriculum seems well within reach.

The conference was also the springboard for an effort to form a professional society, the traditional mechanism for proposing and advancing a curriculum for a discipline. A professional society will also address another requirement of developing an IT curriculum, input from other stakeholders in the educational process such as government, industry and students.

We are continuing our efforts to define an IT curriculum as this is being written. A second conference with a larger base of participating programs is planned for the spring of 2002, and will be completed before this paper is published to press. While it is possible that this curriculum exercise produced results that were anomalous, more likely additional participants will reinforce many of the central themes while adding to the various additional topics that help to define the unique flavors of different programs. As the definition of technical curricula continue to move towards outcomes as the basis of a working definition of programs, and the curricular proposals of accrediting bodies shift from detailed specifications of program minutiae to identification of common cores and general program outcomes, this exercise provided a starting point for defining a curricular umbrella under which many different programs will be able to find a home.

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APPENDIX

CITC Conference Participants

1. Brigham Young University, Hawaii Campus
2. Brigham Young University, Utah Campus
3. Capella University
4. Georgia Southern University
5. Indiana University
6. Macon State College
7. New Jersey Institute of Technology
8. Pace University
9. Pennsylvania College of Technology
10. Purdue University
11. Rochester Institute of Technology
12. SUNY Morrisville
13. University of Baltimore
14. University of Houston
15. University of South Alabama