Defining CS, IS, and IT: Are We There Yet?

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Abstract

It is an important but difficult challenge to reconcile the various definitions of the Information Systems, or Information Technology, field. There have been several recent attempts to come to some agreement in the academic community, but no final definitions have been developed. Equally important is for employers to have some common understanding of the various skills they can expect from graduates of these programs. In order to investigate the currently held beliefs of prospective employers of CS, IS, and IT graduates, a survey was developed which asked about the courses, certifications, and software proficiencies s/he expected graduates in each of the respective disciplines to have completed. Additionally, the prospective employer was asked her/his opinion about the rigor of each of the three disciplines.

Keywords: curriculum, definitions, CS, CIS, IS, IT

1. CHALLENGES, DEFINITIONS AND CONFUSION

The discipline of Information Systems is faced with several challenges. First, it must keep pace with the rapid changes in technology and its use within organizations. Secondly, the curriculum itself must be modified to reflect these changes without focusing entirely on the technology aspect of the discipline (Mitchell, 2003; Clarke, 1999; Davis, 1992). The focus of this paper is on the third challenge – the need to develop a common understanding of the Information Systems discipline that is agreed to by both practitioners and educators. As reported by Lenox and Woratschek (2003), the field of Information Systems suffers from an overabundance of different names, including: Information Systems (IS), Computer Information Systems (CIS), Management Information Systems (MIS), Business Information Systems (BIS), Decision Support Systems (DSS), Information Management (IM), Information Resource Management (IRM), Information Technology Resource Management (ITRM), Information Science, Information Technology (IT), Information Technology Systems (IST), Office Automation Systems (OAS), Accounting Information Systems (AIS), Information and Quantitative Science, and Informatics (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002). According to the authors of the IS 2002 Model Curriculum (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002), these different names reflect "historical development of the field, different ideas about how to characterize it, and different emphases when programs were begun" (p. 10).

2. BACKGROUND AND LITERATURE REVIEW

Is CS that different from IS? Is there an IT computing discipline that is different than

IS? In March 1968, Curriculum '68 was published by the ACM and Computer Science became a distinct discipline from Mathematics (Mitchell, 2003; ACM, 1968). It defined three major subfields of computer science: information structures and process, information processing systems, and methodologies (Tucker & Wegner, 1994; ACM, 1968). By 1981 reports published by IEEE, DPMA (now AITP) and others helped to define three distinct areas of computing: Computer Science, Computer Engineering, and Computer Information Systems (DPMA, 1981; Nunamaker, Cougar & Davis, 1982). These three areas can be seen in the traditional range of computing courses offered by higher educational institutions in the 1980s: hardware (Engineering), software (Computer Science) and applications (Computer Information Systems).

Information Systems as an academic field arose from Computer Science due to the need to effectively use computer-based information systems in organizations. In 1983, ACM published its recommendations for Information Systems (ACM, 1983). Several other curriculum models were developed including the DPMA's 1981, 1986 and IS '90 curricula (DPMA, 1981; DPMA, 1986; Longnecker and Feinstein, 1991) and the IS '95 and '97 model curricula (a joint effort by ACM, AIS, and AITP). The most recent effort is the "IS 2002 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems" which is a collaborative effort among ACM, AIS, and AITP (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002).

It was during that late 1990s that programs in the field of Information Technology began to emerge. Businesses at this time were examining their computer infrastructures trying to determine if there were suitable, worked reliably and efficiently, and if the people who used them had their needs met. The goal of the academic IT programs that were created was to produce college graduates who had the right skills to meet these crucial needs. (Computing Curricula 2005 The Overview Report, p. 11)

The creation of many IT academic programs caused curricular confusion. In an online survey in July, 2001, Lankford, questioned 74 IT professors and discovered a "surprising variety of program names" (p. 1) and differing definitions for IT, IS, MIS, and CS. She found that some respondents defined IT as a separate entity from Information Systems (IS), Management Information Systems (MIS), and Computer Science (CS); while others believed IT was the umbrella under which these other groups or divisions fall (Lankford, 2001). Additionally, several proposed curricula for IT appear to be only revising the IS discipline and not creating a new IT discipline. For example, Finklestein and Hafner (2002) summarize a report presented to a group of 30 deans of colleges and schools of IT who are wrestling with the issues of defining the Information Technology discipline. They propose a continuum for the IT curriculum stretching "from fundamental computing principles (far left), to the impact of technology on society (far right)" (pp. 2-3). The center of this continuum is how to apply cognitive/social constraints to the technology. This definition strongly overlaps with the traditional definition of Information Systems.

From a brief examination of IT curricula in various institutions, (Chu, 2002; Finklestein & Hafner, 2002; Mitchell, 2003), it appears that IT programs, like IS programs, are very diverse and typically multi-disciplinary.

Reichgelt, Lunt, Ashford, Phelps, Slazinski, Willis (2004) studied whether there are significant similarities between baccalaureate programs in IT offered at different institutions, and whether there are significant differences between IT program and programs in CS or IS. Using a number of higher education institutions that offered baccalaureate programs in CS, IS, and IT, they found that CS programs emphasize Software (39%) and Math, Physics & Chemistry (30%); IS programs require courses in Business (58%) and IT programs emphasize networking, web technologies and databases (33%). (p. 28) They also report that programs in IS are more tightly clustered than programs in either CS or IT and that generally speaking IT programs seem to lie between IS and CS programs (p. 30).

The IS 2002 Model Curriculum suggests that there is a large amount of overlapping knowledge between IS and IT and proposes three levels of coursework for IS students which includes IT: 1) General courses in information systems for IS majors and minors, 2) Specialized information technology and application design courses for IS majors and minors, and 3) Specialized application development, deployment, and project management courses for IS majors (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002, pp. v - vi).

Lenox and Woratschek (2004) found little agreement among academicians about the terms CS, IS, IT.

2.1 Computing Curricular 2005: The Overview Report

To date no consensus has been reached regarding the definitions of three sub-disciplines of computing. However, in September, 2005, A Joint Task Force for Computing Curricula published Computing Curricula 2005 The Overview Report. This document which covered undergraduate degree programs in Computer Engineering, CS, IS, IT, and Software Engineering was a cooperative project among three important groups: the Association for Computing Machinery (ACM), the Association for Information Systems (AIS) and the Computer Society (IEEE-CS). The goal of this task force was "to provide perspective for those in academia who need to understand what the major computing disciplines are and how the respective undergraduate degree programs compare and complement each other. This report summarizes the body of knowledge for undergraduate programs in each of the major computing disciplines, highlights their commonalities and differences, and describes the performance characteristics of graduates from each kind of undergraduate degree program" (p. 1).

According to the Overview Report, CS, the oldest and founding discipline, is described as that aspect of computing that spans a wide range of areas including algorithms, robotics, computer vision, intelligent systems, and bioinformatics (p. 13). CS work is categorized into: 1) the design and implementation of software; 2) devising new ways to use computers, and 3) the development of effective ways to solve computing problems (p. 13).

IS is described in the report as the computing discipline that focuses "on integrating information technology solutions and business processes to meet the information needs of business and other enterprises, enabling them to achieve their objects in an effective, efficient way." (p. 14) The emphasis is on information and the role of technology is as an instrument "to enable the generation, processing and distribution of needed information." (p 14) IS specialists require "a sound understanding of organizational principles and practices so that they can serve as a bridge between the technical and management communicates within an organization, enabling them to work in harmony to ensure that the organization has the information and the systems it needs to support its operations." An IS professional is involved in designing technology-based organization communication and collaboration systems (p. 14).

The report also notes that "A majority of *Information Systems* (IS) programs are located in business schools. All IS degrees combine business and computing coursework. A wide variety of IS programs exists under a various labels which often reflect the nature of the program. For example, programs in Computer Information Systems usually have the strongest technology focus, and programs in Management Information Systems can emphasize organizational and behavioral aspects of IS. Degree programs names are not always consistent" (p. 14).

IT has two definitions according to the report. The first definition is very broad and simply states that IT refers to all of computing. The second definition is from an academic viewpoint. Here, IT "refers to undergraduate programs that prepare students to meet the computer technology needs of business, government, healthcare, schools, and other kinds of organizations" (p. 14). IT is the complement of IS emphasizing the technology itself more than the information conveyed (p. 14). "IT programs exist to produce graduates who possess the right combination of knowledge and practical, hands-on expertise to take

care of both an organization's IT infrastructure and the people who use it. IT specialists assume responsibility for selecting hardware and software products appropriate for an organization, integrating those products with organizational needs and infrastructure, and installing customizing and maintaining those specifications for the organization's computer users. Examples of these responsibilities include: the installation of networks, network administration and security; the design of web pages; the development of multimedia resources; the installation of communication components; the oversight of email products; and the planning and management of the technology life-cycle by which an organizations' technology is maintained, upgraded, and replaced" (pp. 14-15).

2.2 Commonalities/Differences Defined

To describe the commonalities and differences between the computing disciplines, the task force created a "problem space of computing." This graphical framework visually illustrates the task forces interpretation of the various disciplines along a five topic dimension. These interpretations are subjective and not based on quantifiable data. The problem spaces for CS, IS, and IT are illustrated in Appendix A with three figures from the original report.

The task force claims that CS is concerned with 1) software that enables devices to work, 2) the design and development of all types of software from systems infrastructure; e.g., OS, communications programs, etc.; and 3) application technologies; i.e., web browsers, databases, search engines, etc. CS specialists create these capabilities, but they do not manage the deployment of them. CS specialists also do not: 1) help people in the selection of computing products, 2) tailor these products to organizational needs, and 3) learn to use such products (p. 18).

The task force claims that in contrast to CS, IS is concerned with the relationship between information systems and the organizations that they serve. This relationship includes not only the theory and principles of such, but also the application and development. IS professionals are involved in: 1) systems deployment and configuration work, 2) user training, 3) tailoring application technologies (especially databases) to the needs of the enterprise, and 4) the development of systems that utilize other software products to suit their organizations' needs for information (p. 19).

In the third problem space, the task force claims that the field of IT focuses on the application, deployment, and configuration needs of organizations and people over a wide spectrum. As can be seen from the figure, the role of IT has some overlap with IS, but IT focuses on satisfying human needs that arise from computing technology. The report notes that IT people often develop the web-enabled digital technologies that organizations use for a broad mix of informational purposes, and this implies an appropriate conceptual foundation in relevant principles and theory (p. 20).

2.3 Curriculum Summaries

In another graphical framework the task force summarizes the emphasis on 40 computing topics across the degree programs. The topics included in the chart below (Figure 2-1) represent the unionization of all of the computing topics specified within each the five major computing disciplines.

The "min" column in the chart represents the minimum emphasis typically placed on that topic as specified in the curriculum report for that computing discipline. It indicates a disciplines' minimum requirement relative to the minimum requirements of the other disciplines. (p. 23)

The "max" column in the chart represents the greatest emphasis that can typically occur within the latitude provided by the curriculum report for that degree. Each discipline permits students some latitude in choosing an area of specialization and requires that a student's program of study go beyond the minimums defined in the curriculum report. It also permits each institution to establish requirements greater than those defined in the five curriculum reports. The "max" value indicates what one might reasonable expect of those who concentrate on topic within the limits implied by other degree requirements. (p. 23).

The values shown in the chart under the "min" and "max" columns range between 0 (lowest) and 5 (highest). These numbers represent the relative emphasis each kind of computing degree program might be reasonably expected to place on each given topic. They are not exact measures of emphasis each discipline pays to these topics (p. 23).

Another chart of emphasis was constructed for what the task force calls the 'soft' side or non-computing topics. The report notes that "two of the computing disciplines lie at the boundary between computing and other disciplines…The *information systems* discipline spans the boundary between computing and business." (p. 23)

Knowledge Area	CE		CS		IS		IT		SE	
	min	max	min	max	min	max	min	max	min	max
Programming Fundamentals	4	4	4	5	2	4	2	4	5	5
Integrative Programming	0	2	1	3	2	4	3	5	1	3
Algorithms and Complexity	2	4	4	5	1	2	1	2	3	4
Computer Architecture and Organization	5	5	2	4	1	2	1	2	2	4
Operating Systems Principles & Design	2	5	3	5	1	1	1	2	3	4
Operating Systems Configuration & Use	2	3	2	4	2	3	3	5	2	4
Net Centric Principles and Design	1	3	2	4	1	3	3	4	2	4
Net Centric Use and configuration	1	2	2	3	2	4	4	5	2	3
Platform technologies	0	1	0	2	1	3	2	4	0	3
Theory of Programming Languages	1	2	3	5	0	1	0	1	2	4
Human-Computer Interaction	2	5	2	4	2	5	4	5	3	5
Graphics and Visualization	1	3	1	5	1	1	0	1	1	3
Intelligent Systems (AI)	1	3	2	5	1	1	0	0	0	0
Information Management (DB) Theory	1	3	2	5	1	3	1	1	2	5
Information Management (DB) Practice	1	2	1	4	4	5	3	4	1	4
Scientific computing (Numerical mthds)	0	2	0	5	0	0	0	0	0	0
Legal / Professional / Ethics / Society	2	5	2	4	2	5	2	4	2	5
Information Systems Development	0	2	0	2	5	5	1	3	2	4
Analysis of Business Requirements	0	1	0	1	5	5	1	2	1	3
E-business	0	0	0	0	4	5	1	2	0	3
Analysis of Technical Requirements	2	5	2	4	2	4	3	5	3	5
Engineering Foundations for SW	1	2	1	2	1	1	0	0	2	5
Engineering Economics for SW	1	3	0	1	1	2	0	1	2	3
Software Modeling and Analysis	1	3	2	3	3	3	1	3	4	5
Software Design	2	4	3	5	1	3	1	2	5	5
Software Verification and Validation	1	3	1	2	1	2	1	2	4	5
Software Evolution (maintenance)	1	3	1	1	1	2	1	2	2	4
Software Process	1	1	1	2	1	2	1	1	2	5
Software Quality	1	2	1	2	1	2	1	2	2	4
Comp Systems Engineering	5	5	1	2	0	0	0	0	2	3
Digital logic	5	5	2	3	1	1	1	1	0	3
Embedded Systems	2	5	0	3	0	0	0	1	0	4
Distributed Systems	3	5	1	3	2	4	1	3	2	4
Security: issues and principles	2	3	1	4	2	3	1	3	1	3
Security: implementation and mgt	1	2	1	3	1	3	3	5	1	3
Systems administration	1	2	1	1	1	3	3	5	1	2
Management of Info Systems Organ'tion	0	0	0	0	3	5	0	0	0	0
Systems integration	1	4	1	2	1	4	4	5	1	4
Digital media development	0	2	0	1	1	2	3	5	0	1
Technical support	0	1	0	1	1	3	5	5	0	1

Figure 2-1 Comparative Weight of Computing Topics Across the Five Kinds of Degree Programs (Source: Table 3.1, Computing Curricula 2005 – The Overview Report, p. 24)

Knowledge Area	CE		CS		IS		IT		SE	
	min	max	min	max	min	max	min	max	min	max
Organizational Theory	0	0	0	0	1	4	1	2	0	0
Decision Theory	0	0	0	0	3	3	0	1	0	0
Organizational Behavior	0	0	0	0	3	5	1	2	0	0
Organizational Change Management	0	0	0	0	2	2	1	2	0	0
General Systems Theory	0	0	0	0	2	2	1	2	0	0
Risk Management (Project, safety risk)	2	4	1	1	2	3	1	4	2	4
Project Management	2	4	1	2	3	5	2	3	4	5
Business Models	0	0	0	0	4	5	0	0	0	0
Functional Business Areas	0	0	0	0	4	5	0	0	0	0
Evaluation of Business Performance	0	0	0	0	4	5	0	0	0	0
Circuits and Systems	5	5	0	2	0	0	0	1	0	0
Electronics	5	5	0	0	0	0	0	1	0	0
Digital Signal Processing	3	5	0	2	0	0	0	0	0	2
VLSI design	2	5	0	1	0	0	0	0	0	1
HW testing and fault tolerance	3	5	0	0	0	0	0	2	0	0
Mathematical foundations	4	5	4	5	2	4	2	4	3	5
Interpersonal communication	3	4	1	4	3	5	3	4	3	4

Figure 2-2 Comparative Weight of Non-Computing Topics Across the Five Kinds of Degree Programs (Source: Table 3-2, Computing Curricula 2005 – The Overview Report, p. 25)

In a separate document entitled Computing Curricula Information Technology Volume, the Special Interest Group for Information Technology Education (SIGITE) of the ACM set out to establish an IT curriculum. This document defines IT as an academic discipline: "Information Technology (IT) in its broadest sense encompasses all aspects of computing technology. IT, as an academic discipline, focuses on meeting the needs of users within an organizational and societal context through the **selection, creation, application, integration and administration** of computing technologies" (p. 5).

The Computing Curricula Information Technology Volume states that "information Technology is very much an integrative discipline; it pulls together the IT pillars of databases, human-computer interaction, networking, programming, and web systems and uses a solid background in each of them to enable graduates to solve all types of computing and information problems, regardless of their origin. As a discipline, IT emphasizes user centeredness and advocacy, information assurance and security, and the management of complexity through abstraction and modeling, best practices, patterns, standards, and the use of appropriate tools" (p. 22).

Clearly, the beliefs about the differences among the computing disciplines are wide ranging. However these labels originated, their proliferation and the resulting confusion concerning their meaning may have an adverse affect on recruiting, retaining, and hiring students.

3. RESULTS AND DISCUSSION

To investigate current beliefs about the disciplines related to the Computer Science disciplines a survey was developed and distributed to 50 individuals. These individuals had to meet the criteria of being a manager in a computer environment and directly responsible for hiring entry-level computer related positions. The individuals were chosen from alumni, masters and doctoral level student's companies of Robert Morris University, a small University located in Pittsburgh, PA. Of the 50 individuals contacted, 19 responded (38%).

The survey was divided into four parts: Parts I & II asked questions regarding the respondent and his/her personal and company background, Part III asked questions about the curricular content of CS/CIS/IS/IT, and Part IV asked about the rigor of undergraduate degrees in the computer science related disciplines. One of the questions in the first part of the survey questioned the respondent as to his/her undergraduate degree. The respondent could choose "CS," "CIS,"" IS," "IT," or "none of the above." The survey results are reported using these categories and are found in Appendix B.

3.1 Respondent Background

Table 3-1 illustrates the respondents' degree background. Of the 19 respondents, two have an undergraduate degree in CS (10%), four have an undergraduate degree in CIS (21%), three have and undergraduate degree in IS (16%), three have an undergraduate degree in IT (16%) and

seven indicated that their undergraduate degree is not in one of these computer-related disciplines (37%).

Table 3-2 shows that the majority of the respondents (42%) work in Healthcare (pharmaceuticals) and most do not have an undergraduate degree in a computer-related discipline; or they work in the Financial/Insurance area (37%).

Table 3-3 indicates that the majority of respondent (37%) work for a company with an annual revenue between $4 and 9.9 billion dollars annually.

Table 3-4 illustrates that the majority of respondents (68%) work for a company that employs 150 or more computer-based professionals. Table 3-5 indicates that the majority of respondents (42%) work for a company with 50 or more new computer-based positions available annually. The majority of respondents (37%) either have Manager/Consulting Manger or Systems Analyst/Programmer/Systems Engineer/IT Consultant as their job title. Job titles are shown in Table 3-6. Table 3-7 shows that forty-seven percent (47%) of the respondents have between 13-18 years of professional work experience.

3.2 Computer Curriculum

The first question regarding computer-related curriculum asked the respondent to consider a 'new hire' candidate with an undergraduate degree in CS. The respondent was asked to select the courses s/he expected the candidate to have successfully completed for this degree. Table 3-8 summarizes the results.

All respondents (2) with a CS undergraduate degree agreed that this candidate should have completed the following courses: Introduction to Java Programming, Introduction to C++ Programming, Advanced C++ Programming, Assembly Language Programming, LISP and Symbolic Programming, Artificial Intelligence, Data Structures/File Organizations, Operating systems, Complier Design, Web Design/Programming, and Object-Oriented Systems Analysis and Design.

All respondents (4) with a CIS undergraduate degree indicated that this candidate should have completed: Information Storage and Retrieval and Operating Systems. Three of the four respondents agreed that the candidate should have completed Introduction to Java Programming, Introduction to Visual BASIC Programming, Web Design/Programming, and Networks and Telecommunications.

All respondents (3) with an IS undergraduate degree indicated that this candidate should have completed: Introduction to Java Programming, Introduction to C++ Programming, and Data Structures/File Organizations.

All respondents (3) with a IT undergraduate degree indicated that this candidate should have completed: Data Structures/File Organizations, Operating Systems, Introduction to Database Management Systems, and Object-Oriented Systems Analysis and Design.

All respondents (7) who indicated that they do not have an undergraduate degree in a computer-related field felt that this candidate should have completed: Object-Oriented Systems Analysis and Design. Six of the seven respondents felt that the candidate should have completed Introduction to Java Programming, Introduction to C++ Programming, Introduction to Visual BASIC Programming, Data Structures/File Organizations, Systems Analysis and Design, and Networks and Telecommunications.

Overall, the majority of respondents felt that this candidate should have completed courses in: Operating Systems (89%), Data Structures/File Organizations (84%), Introduction to Java Programming, Introduction to C++ Programming, and Object-Oriented Systems Analysis (79%) and Web Design/Programming and Information Storage and Retrieval (74%).

There are no courses that all respondents agreed that this candidate should have completed. This is surprising given the fact that CS is the oldest of the computer-related disciplines and the one most associated with programming, computer architecture, operating systems, and data structures and algorithms.

The respondents were asked if they expected the candidate to be proficient in a variety of different software. Table 3-9 summarizes the results.

All of the respondents regardless of their undergraduate degree (19) unanimously agreed that this candidate should be proficient in MS Excel and 18 of the 19 (95%) said that the candidate should be proficient in MS Word. This result was expected due to the popularity and powerful capabilities of these software packages.

The respondents were asked if they expected this candidate to have completed and certifications. The majority, regardless of their undergraduate degree, did not indicate that they expected this candidate to have completed any of the certifications listed. Table 3-10 summarizes these results. This result is not surprising since the validity of certifications has been debated for some time.

The next question regarding computer-related curriculum asked the respondent to consider a 'new hire' candidate, but this time with an undergraduate degree in IS. The respondent was asked to select the courses s/he expected the candidate to have successfully completed for this degree. The results are summarized in Table 3-11.

All respondents except those with an IT undergraduate degree wanted this candidate to be proficient with MS Word, and MS Excel. All of those respondents with an undergraduate degree in CS wanted this candidate to be additionally proficient with MS PowerPoint and MS Access. Overall, the majority of respondents wanted this candidate to be proficient with MS Word and MS Excel, but there was no unanimous agreement regarding software proficiencies. Table 3-12 summarizes these results

There were no courses agreed upon unanimously. However, the majority of respondents, regardless of their undergraduate degree, felt that this candidate should have completed: Introduction to Database Management Systems (95%), Data Structures/File Organizations and Systems Analysis and Design (89%), Introduction to Java Programming (84%), and Introduction to Visual BASIC Programming and Web Design/Programming (79%).

As before, the majority of respondents did not indicate that they expected this candidate to have completed any certifications. And, again, these results are not surprising. Table 3-13 summarizes these results.

The last question regarding computer curriculum asked of the respondents was to consider a 'new hire' candidate with an undergraduate degree in IT. The respondent was asked to select the courses s/he expected the candidate to have successfully completed for this degree. Table 3-14 summarizes these results.

All respondents (2) with a CS degree indicated that this candidate should have successfully completed: Data Structures/File Organizations, Introduction to Database Management Systems, and Networks and Telecommunications.

All respondents (4) with a CIS degree felt that this candidate should have successfully completed: Information Storage and Retrieval, Human Computer Interaction, and Data Structures/File Organizations.

There was no unanimous agreement among respondents (3) with an IS degree as to the courses this candidate should have successfully completed.

All respondents (3) with an IT degree indicated that this candidate should have successfully completed: Introduction to C++ Programming, Introduction to Visual BASIC Programming, Information Storage and Retrieval, Operating Systems, Web Design/Programming, and Systems Analysis and Design.

All respondents (7) who do not have an undergraduate degree in a computer-related discipline felt that this candidate should have successfully completed: Introduction to Java Programming and Web Design/ Programming.

There was no unanimous agreement as to what courses the candidate should have successfully completed. The courses that had the highest agreement were:

Information Storage and Retrieval, Web Design/Programming, and Systems Analysis and Design, but only 15 of the 19 respondents (79%) agreed.

The Web Design/Programming course is the only course that respondents believed both CS and IS candidates should have completed.

Although the sample size for this study is small, the data indicates that those individuals who have an undergraduate degree in the discipline that s/he is interviewing a candidate for have a clearer picture of the course work in that discipline. The data also indicates that the course work expected in each of the disciplines by those individuals who have the same degree as the candidate they are interviewing closely matches the course curriculum as set by the various disciplines – Computing Curricula 2001 – Computer Science, IS 2002 Model Curriculum (Gorgone, Davis, Valacich, Topi, Feinstein, & Longnecker, 2002).

It is also clear from the results of the course comparison that the lines between the disciplines of CS, IS, and IT are blurred, at least they are in each of the other discipline's eyes.

All respondents with CS, CIS, or IT undergraduate degrees felt that this candidate should be proficient with MS Word and MS Excel. There was no unanimous agreement among those respondents who had a non computer-related degree or from the respondents collectively as to the software proficiencies expected of this candidate. All of those respondents with an undergraduate degree in CS also wanted this candidate to be proficient with MS PowerPoint and MS Access. Table 3-15 summarizes the results.

Janicki et. al. (2004) in an exploratory study matching employer needs with IT curriculum compared the personal productivity software expectancies of both entry level and above entry level new hires. They found that at the above entry level, employers expected candidates to be proficient in personal productivity software, but not so at the entry level. The software in question included MS Word, MS Excel, MS Access, MS PowerPoint, MS Project, and MS Front Page. The results of this study differ in that the majority of respondents expected candidates regardless of their degree to be proficient in MS Word, MS Excel, and MS PowerPoint at the entry level. Again, the majority of respondents did not indicate that they expected this candidate to have completed any certifications. Table 3-16 summarizes the responses.

3.3 Rigor of Computer-related Degrees

The final part of the survey asked the respondents to consider a number of statements regarding a comparison of the rigor of the computer-related degrees and their opinion to several statements. Table 3-17 summarizes these results.

All respondents with a CS undergraduate degree agreed with both of the following statements:

1) A Computer Science undergraduate degree is a more rigorous degree than an Information Science undergraduate degree, and 2) A Computer Science undergraduate degree is a more rigorous degree than an Information Technology undergraduate degree.

All respondents with an IT undergraduate degree agreed with the statement: "A Computer Science undergraduate degree is a more rigorous degree than Information Technology undergraduate degree."

There was no consensus among those respondents who have undergraduate degrees in either CIS, IS, or do not have an undergraduate degree in a computer related discipline as to which degree(s) were more rigorous than others. For those individuals who do not have a degree in a computer-related profession, the highest consensus was 4 out of 7 (57%) who agreed with the statement: " Computer Science, Information Systems/Science and Information Technology undergraduate degrees are all equivalent."

Of special interest is one respondent's comment. This individual does not have an undergraduate degree in a computer-related discipline and handwrote a note on the survey which states: "It depends on the

institution which granted the degree as to which statement is true."

Based on these results, the CS respondents definitely believe their degree is more rigorous than the others and the IT respondents agree with them. The results of the course expectations for each of the 'new hire' scenarios supports the statement agreed on by the majority of the respondents who do not have a computer-related degree: "Computer Science, Information Systems/Science and Information Technology undergraduate degrees are all equivalent."

If this indeed is the perception that individuals who do not have an undergraduate degree in a computer-related discipline have of CS, IS, and IT, perhaps it is necessary to re-think the need for distinct discipline and have a generic degree such as 'computer studies.'

Is it not true that in an effort to keep current in the computer discipline and maintain or increase enrollments, many programs offer courses that are not actually part of the discipline of their department? For example, consider a CS program which offers courses in Advanced Systems Analysis, Human Computer Interaction, LAN design, Windows 2003 Server, Advanced M programming for the Health Care Professions or Business Intelligence. If so then are we not already "computer studies" rather than CS, IS, or IT?

In an effort to increase enrollment and provide more flexibility in its Computer Science program at the Georgia Institute of Technology made major changes to its CS curriculum this academic year. The Institute abolished the core curriculum for CS undergraduates and introduced a new one. This new curriculum is called 'Threads' and its implementation has increased enrollment in the freshman class 33%. 'Threads" consists of two main parts.

> *In the first part, students pick two of eight possible "threads" of instruction. These are a series of courses – with requirements that collectively are as demanding as the old core courses – that related to a use of computer science. For example, computational modeling deals with using computer science to represent natural and physical processes; intelligence deals with building "top to bottom models of human-level intelligence," and media involves systems "to exploit computing's abilities to provide creative outlets." There are a total of 28 possible combinations of threads that student may select. Many of the required courses will be taught involving material and faculty members outside of computer science.*
>
> *Then in their first year enrolled, students will also track themselves by "role," picking among master practitioners (programmers), entrepreneurs, innovators or communicators. Academic advisers will work with students so that their role helps determine both their instructional choices and also their non-instructional education (making sure that entrepreneurs learn how to write business plans, for example). Students making the same "thread" choice could still end up with a different educational focus if they sought out different roles. The role is as much about having advisers keep students oriented toward a goal as about curricular requirements per se. (Jaschick, 2006)*

Pace University has also made changes to its undergraduate CS curriculum. Now "a major emphasis is combing computer science degrees with other departments, for example criminal justice or finance" (Jaschick, 2006).

These two examples only blur the lines between the computer-related disciplines moving the traditional CS curriculum more toward the IS/IT curriculum. One does not traditionally think of a CS undergraduate working in finance or writing business plans. If this is to be the direction of the new curricula then perhaps there is no need for a differentiation between CS, IS, and IT. Rather, our efforts should be combined and the curriculum could provide elements of each discipline as they are currently defined by their respective curricula and the student can design their own program of 'computer studies.'

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Appendix A

Charts from Computing Curricula 2005 -- The Overview Report. The Joint Take Force for Computing Curricula 2005. A cooperative project of ACM, AIS, IEEE-CS, September 30, 2005.

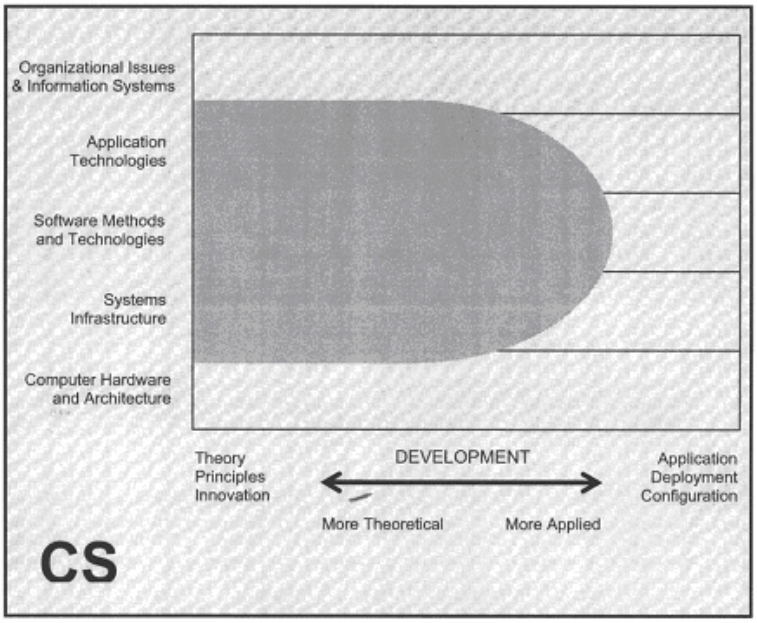

Figure 2.4 Computer Science, pg. 18.

Graphical characterization of the Computer Science discipline.

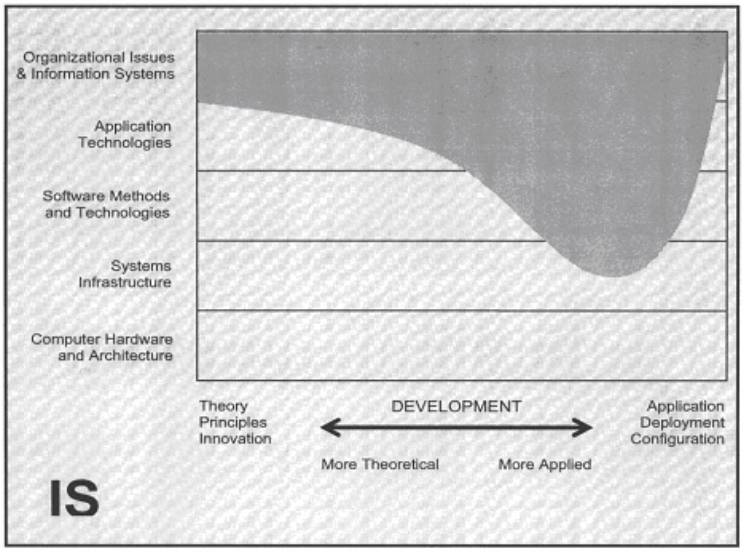

Figure 2.5 Information Systems, pg. 19.

Graphical characterization of the Information Systems discipline.

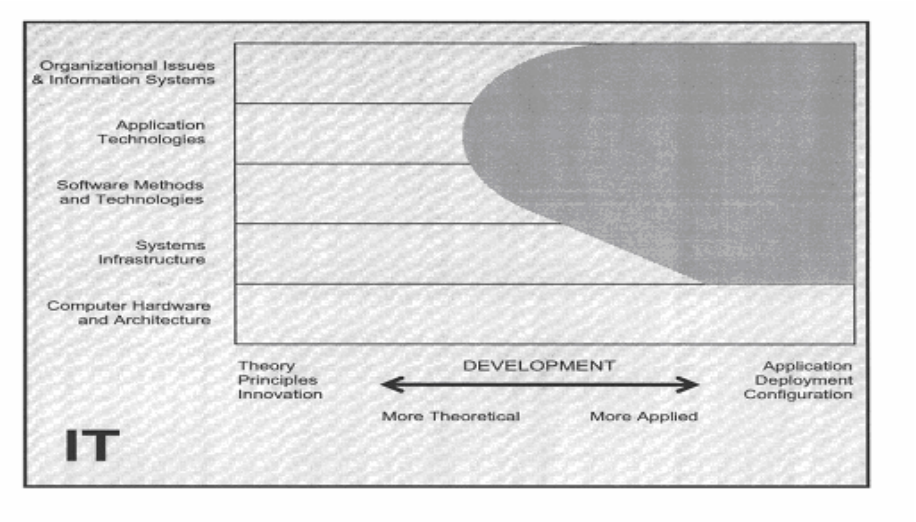

Figure 2.6 Information Technology, pg. 20.

Graphical characterization of the Information Technology discipline.

APPENDIX B – TABLES

Which of the following best describes the nature of your company?	CS	CIS	IS	IT	Non Computer-Related Degree	Total
Computer/computer services/IT consulting		2			1	3
Healthcare, pharmaceuticals	1		2		5	8
Aerospace/defense						0
Manufacturing						0
Publishing, printing						0
Chemical, oil and gas						0
Utilities						0
Financial Services/Insurance	1	1	1	3	1	7
Other		1				1
N =	2	4	3	3	7	19

Table 3-1 Respondent Background

Which of the following best describes the nature of your company?	CS	CIS	IS	IT	Non Computer-Related Degree	Total
Computer/computer services/IT consulting		2			1	3
Healthcare, pharmaceuticals	1		2		5	8
Aerospace/defense						0
Manufacturing						0
Publishing, printing						0
Chemical, oil and gas						0
Utilities						0
Financial Services/Insurance	1	1	1	3	1	7
Other		1				1
N =	2	4	3	3	7	19

Table 3-2 Respondent Company Business

Which of the following best describes your company size (in annual revenue)?	CS	CIS	IS	IT	Non Computer-Related Degree	Total
Less than $100 million				1	1	2
$100 - 499 million				2		2
$500 - 999 Million						0
$1 - 3.9 billion					1	1
$4 - 9.9 billion	1	2	1		3	7
$10 billion or more		1	2		1	4
No response	1	1			1	3
N =	2	4	3	3	7	19

Table 3-3 Annual Revenues of the Respondent Company

Approximately, how many computer-based professionals are employed by your company?	CS	CIS	IS	IT	Non Computer-Related Degree	Total
less than 5						1
5 – 9	1			3	1	5
10 – 14						0
15 – 49					1	1
50 – 99						0
100 – 149						0
150 or more	1	4	3		5	13
N =	2	4	3	3	7	19

Table 3-4 Computer-based Professional Employees at Respondent's Company

What is the number of "new hires" for computer-based positions per year?	CS	CIS	IS	IT	Non Computer-Related Degree	Total
less than 5	1			2	1	4
5 – 9				1		1
10 – 19			1			1
20 – 29					1	1
30 – 49		1	1		1	3
50 or more	1	3	1		3	8
No response					1	1
N =	2	4	3	3	7	19

Table 3-5 Computer-based Positions Available Annual in Respondent's Company

Which of the following best describes your job title?	CS	CIS	IS	IT	Non Computer-Related Degree	Total
CIO/VP, Info. Systems/IS Director	2				1	3
Manager/Consulting Manager		1	1		5	7
Project Leader			1		1	2
Sys. Analyst/Programmer/Sys. Engineer/IT Consultant		3	1	3		7
Human Resources Professional						0
Other						0
N =	2	4	3	3	7	19

Table 3-6 Respondent Job Title

How many years of Professional Work Experience do you have?	CS	CIS	IS	IT	Non Computer-Related Degree	Total
less than 3				1		1
3 – 7	1			1		2
8 – 12			1	1	1	3
13 – 18	1	2	1		5	9
19 – 24			1			1
25 or more		2			1	3
N =	2	4	3	3	7	19

Table 3-7 Professional Work Experience

Consider the situation where you are hiring for an entry-level position. The candidate you are interviewing has an undergraduate degree in Computer Science. Below, please check all of the courses you would expect this candidate to have taken to successfully complete this degree.						
	Candidate would have taken this course					
Course	**CS**	**CIS**	**IS**	**IT**	**Non Computer-Related Degree**	**Total**
Introduction to Java Programming	2	3	3	1	6	15
Advanced Java Programming	1	1	2	1	4	9
Introduction to C++ Programming	2	2	3	2	6	15
Advanced C++ Programming	2	1	2	1	4	10
Introduction to Visual BASIC Programming		3	2	2	6	13
Advanced Visual BASIC Programming		1			5	6
Introduction to COBOL Programming		1	2	2	1	6
Advanced COBOL Programming		1	1		1	3
Assembly Language Programming	2	2	1	1		6
LISP and Symbolic Programming	2			1		3
Graphics	1	2			5	8
Artificial Intelligence	2				1	3
Robotics	1				1	2
Information Storage and Retrieval	1	4	2	2	5	14
Human Computer Interaction	1	2		2	2	7
Human Information Processing	1	1			1	3
Data Structures/File Organizations	2	2	3	3	6	16
Operating Systems	2	4	1	3	7	17
Compiler Design	2	2	1	2	1	8
Geographic Information Systems						0
Web Design/Programming	2	3	2	2	5	14
Advanced Web Design/Programming	1		1		2	4
E-commerce Strategy, Architecture & Design	1	1			5	7
Introduction to Database Management Systems	1	2	2	3	5	13
Advanced Database Management Systems				1	2	3
Systems Analysis and Design	1	2	2	2	6	13
Object-Oriented Systems Analysis and Design	2	1	2	3	7	15
Networks and Telecommunications		3		2	6	11
Advanced Networks and Telecommunications		2		1	2	5
Project Management and Practice		1	1		4	6
						0
Risk & Strategic Analysis					1	1
N =	2	4	3	3	7	19

Table 3-8 Courses Respondents Expect a **Computer Science** Candidate to Have Completed

Would you expect the candidate to be proficient in any of the following software? Please check all that apply.						
	Candidate would be proficient in					
Software	**CS**	**CIS**	**IS**	**IT**	**Non Computer-Related Degree**	**Total**
MS Word	2	4	3	3	6	18
MS Excel	2	4	3	3	7	19
MS PowerPoint	2	2	2	2	5	13
MS Access	2	2	1	1	4	10
MS Front Page	1		1		1	3
MS Project Manager	1				4	5
Corel Draw					1	1
Visio	2	2	1	1	5	11
Case Tool		1			4	5
N =	2	4	3	3	7	19

Table 3-9 Expectations Regarding Software Proficiencies for a **Computer Science** Candidate

Would you expect that the candidate would have completed any of the following certifications? Please check all that apply.						
	Candidate would have completed					
Certification	**CS**	**CIS**	**IS**	**IT**	**Non Computer-Related Degree**	**Total**
A+	1				1	2
N+	1					1
Security+						0
Microsoft Certified Desktop Support Technician						0
Microsoft Certified Systems Administrator		1				1
Microsoft Certified Systems Engineer		1			1	2
Microsoft Certified Data Base Administrator					1	1
Microsoft Certified Application Developer		1			1	2
Microsoft Certified Solution Developer		1				1
Certified Novell Administrator		1				1
Certified Linux Engineer		1			1	2
Certified Novell Engineer		1				1
Certified Novell Directory Engineer		1			1	2
Cisco Certified Internetwork Engineer		1				1
Project Management Professional						0
N =	2	4	3	3	7	19

Table 3-10 Expectations Regarding Certifications for a **Computer Science** Candidate

Consider the situation where you are hiring for an entry-level position. The candidate you are interviewing has an undergraduate degree in Information Systems/Science. Below, please check all of the courses you would expect this candidate to have taken to successfully complete this degree.						
	Candidate would have taken this course					
Course	**CS**	**CIS**	**IS**	**IT**	**Non Computer Related Degree**	**Total**
Introduction to Java Programming	1	4	3	2	6	16
Advanced Java Programming			2		3	5
Introduction to C++ Programming	1	3	3	1	5	13
Advanced C++ Programming			2		1	3
Introduction to Visual BASIC Programming	1	3	3	2	6	15
Advanced Visual BASIC Programming	1				3	4
Introduction to COBOL Programming	1	2	2	1	1	7
Advanced COBOL Programming	1	1			1	3
Assembly Language Programming		1			1	2
LISP and Symbolic Programming			1		2	3
Graphics		2			6	8
Artificial Intelligence		1			1	2
Robotics		1			2	3
Information Storage and Retrieval	2	3	2	1	3	11
Human Computer Interaction	1	3	1	3	2	10
Human Information Processing	1	2	1	1	3	8
Data Structures/File Organizations	1	3	3	3	7	17
Operating Systems		1		3	3	7
Compiler Design					1	1
Geographic Information Systems	1	1	1		1	4
Web Design/Programming		3	3	2	7	15
Advanced Web Design/Programming		1	2		4	7
E-commerce Strategy, Architecture and Design	1	2	2	2	5	12
Introduction to Database Management Systems	2	4	3	3	6	18
Advanced Database Management Systems	2		1	1	3	7
Systems Analysis and Design	1	4	3	2	7	17
Object-Oriented Systems Analysis and Design	1	4	1	1	3	10
Networks and Telecommunications	1	2	1	3	4	11
Advanced Networks and Telecommunications	1		1		1	3
Project Management and Practice	1	2		1	5	9
Risk & Strategic Analysis					1	1
N =	2	4	3	3	7	19

Table 3-11 Courses Respondents Expect an **Information Systems/Science** Candidate To Have Completed

Would you expect the candidate to be proficient in any of the following software? Please check all that apply.						
	Candidate would be proficient in					
Software	**CS**	**CIS**	**IS**	**IT**	**Non- Computer Related Degree**	**Total**
MS Word	2	4	3	2	7	18
MS Excel	2	4	3	2	7	18
MS PowerPoint	2	2	2	1	6	13
MS Access	2	1	1	2	3	9
MS Front Page	1	1	1	1	2	6
MS Project Manager	1				5	6
Corel Draw						0
Visio	1	1	1	1	4	8
Case Tool					3	
N =	2	4	3	3	7	19

Table 3-12 Expectations Regarding Software Proficiencies for an **Information Systems/Science** Candidate

Would you expect that the candidate would have completed any of the following certifications? Please check all that apply.						
	Candidate would have completed					
Certification	**CS**	**CIS**	**IS**	**IT**	**Non Computer-Related Degree**	**Total**
A+				1	1	2
N+				1		1
Security+				1		1
Microsoft Certified Desktop Support Technician		1			1	2
Microsoft Certified Systems Administrator					1	1
Microsoft Certified Systems Engineer						0
Microsoft Certified Data Base Administrator						0
Microsoft Certified Application Developer		1				1
Microsoft Certified Solution Developer		1				1
Certified Novell Administrator						0
Certified Linux Engineer						0
Certified Novell Engineer						0
Certified Novell Directory Engineer						0
Cisco Certified Internetwork Engineer						0
Project Management Professional		1			1	2
N =	2	4	3	3	7	19

Table 3-13 Expectations Regarding Certifications for an **Information Systems/Science** Candidate

Consider the situation where you are hiring for an entry-level position. The candidate you are Interviewing has an undergraduate degree in Information Technology. Below, please check all of the courses you would expect this candidate to have taken to successfully complete this degree.						
	Candidate would have taken this course					
Course	**CS**	**CIS**	**IS**	**IT**	**Non Computer-Related Degree**	**Total**
Introduction to Java Programming	1	2	1	2	7	13
Advanced Java Programming					3	3
Introduction to C++ Programming	1	1	1	3	5	11
Advanced C++ Programming					1	1
Introduction to Visual BASIC Programming	1	2	2	3	5	13
Advanced Visual BASIC Programming	1				2	3
Introduction to COBOL Programming	1	1	1	1		4
Advanced COBOL Programming	1	1				2
Assembly Language Programming						0
LISP and Symbolic Programming					1	1
Graphics		1			5	6
Artificial Intelligence		2	1		1	4
Robotics		2	1		1	4
Information Storage and Retrieval	1	4	1	3	6	15
Human Computer Interaction		4	1		3	8
Human Information Processing	1	3	1		1	6
Data Structures/File Organizations	2	4	1	1	5	13
Operating Systems		2		3	6	11
Compiler Design						0
Geographic Information Systems	1	2			1	4
Web Design/Programming		3	2	3	7	15
Advanced Web Design/Programming		1		1	4	6
E-commerce Strategy, Architecture and Design		3	1	2	6	12
Introduction to Database Management Systems	2	3	2	1	6	14
Advanced Database Management Systems	1	1		1	3	6
Systems Analysis and Design	1	3	2	3	6	15
Object-Oriented Systems Analysis and Design		2	1	1	4	8
Networks and Telecommunications	2		1	2	4	9
Advanced Networks & Telecommunications	1	1			1	3
Project Management and Practice	1	1	2	1	6	11
Risk & Strategic Analysis					1	1
N =	2	4	3	3	7	19

Table 3-14 Courses Respondents Expect an **Information Technology** Candidate To Have Completed

Would you expect the candidate to be proficient in any of the following software? Please check all that apply.						
	Candidate would be proficient in					
Software	**CS**	**CIS**	**IS**	**IT**	**Non Computer-Related Degree**	**Total**
MS Word	2	4	2	3	6	17
MS Excel	2	4	2	3	6	17
MS PowerPoint	2	3	1	2	4	12
MS Access	2	2		2	3	9
MS Front Page	1			1	1	3
MS Project Manager	1	1		1	3	6
Corel Draw						0
Visio	1	1	1	1	2	6
Case Tool					1	1
N =	2	4	3	3	7	19

Table 3-15 Expectations Regarding Software Proficiencies for an **Information Technology** Candidate

Would you expect that the candidate would have completed any of the following certifications? Please check all that apply.						
	Candidate would have completed					
Certification	**CS**	**CIS**	**IS**	**IT**	**Non Computer-Related Degree**	**Total**
A+	1			1	1	3
N+	1			1	1	3
Security+				1	1	2
Microsoft Certified Desktop Support Technician		1			1	2
Microsoft Certified Systems Administrator					1	1
Microsoft Certified Systems Engineer						0
Microsoft Certified Data Base Administrator						0
Microsoft Certified Application Developer						0
Microsoft Certified Solution Developer						0
Certified Novell Administrator						0
Certified Linux Engineer					1	1
Certified Novell Engineer						0
Certified Novell Directory Engineer						0
Cisco Certified Internetwork Engineer						0
Project Management Professional		1				1
N =	2	4	3	3	7	19

Table 3-16 Expectations Regarding Certifications for an **Information Technology** Candidate

Consider the statements below. Please check the statement(s) that best describe(s) your opinion.	CS	CIS	IS	IT	Non Computer-Related Degree	Total
Computer Science, Information Systems/Science and Information Technology undergraduate degrees are all equivalent.		2	1		4	7
A Computer Science undergraduate degree is a more rigorous degree than an Information Science undergraduate degree.	2	1	1	1	2	7
A Computer Science undergraduate degree is a more rigorous degree than an Information Technology undergraduate degree.	2	1	1	3	2	9
An Information Systems/Science under-graduate degree is a more rigorous degree than a Computer Science degree.		2				2
An Information Systems/Science under-graduate degree is a more rigorous degree than an Information Technology degree				1		1
An Information Technology undergraduate degree is a more rigorous degree than a Computer Science undergraduate degree.		1				1
An Information Technology undergraduate degree is a more rigorous degree than an Information Systems/Science degree.					1	1
No Response			1			1
N =	2	4	3	3	7	19

Table 3-17 Respondent's Opinion Regarding the Rigor of CS, IS, and IT Degrees