Reaching a New Audience: Development of Computer-Centric Minor

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Abstract

The number of students enrolling in computer science programs is decreasing. The number of women enrolling in computer science is also decreasing. What isn't decreasing, however, is the need by companies for their employees to enter the workforce with computer knowledge. In answer to these decreasing numbers and increasing demands, computer science programs need to re-examine what constitutes a computer science program as well as how to meet the technical demands of employers.

Introduction

Computer Science Enrollments

The Department of Computer Science at the University of North Carolina Wilmington (UNCW), as well as the Department of Information Systems and Operations Management, have seen a decrease in the number of students enrolling in their programs. They are not alone. The number of first-year students entering computer science programs across the U.S. is decreasing. Yet, the number of students enrolling in college is on the rise. Figure 1 shows college entrance figures from 1990-2004.

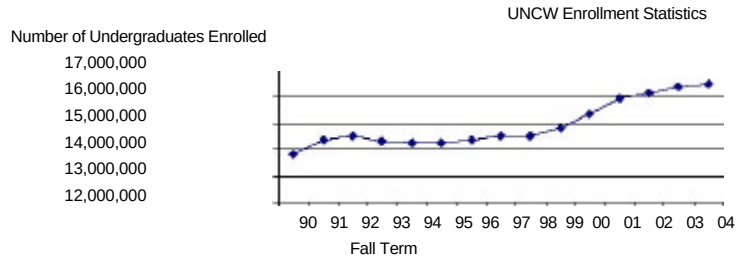

Figure 1. College enrollment statistics, U.S. [1].

Computer Skill Demand by Employers

While enrollment in colleges and universities is on the increase, enrollment in computer science is on the decrease. Figure 2 shows computer science enrollment statistics. The expected trend for enrollments is expected to continue to decline over the next ten years [2].

While the number of students entering computer science is decreasing, the demand for students with computer knowledge is increasing. Admittedly, "computer knowledge" may not mean as extensive a knowledge as a computer scientist may have. In two surveys conducted at UNCW, employers were asked about their hiring needs.

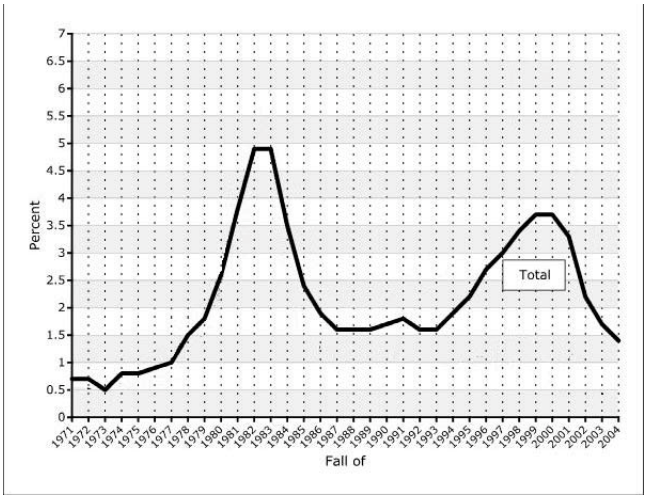

Figure 2. Computer science listed as probable major among incoming first-year students [2].

The first survey was conducted by UNCW's Information Systems and Operations Management (ISOM) Department. Local businesses were asked to estimate their hiring needs within a variety of computer technical areas such as database knowledge, graphic design, and networks [3]. Although this survey does not provide a clear indication of their technical needs, it does suggest that companies have a need for employees with "some" level of computer skills. Results of this preliminary survey follow in Table 1. This survey was further supported by the second survey which was conducted by UNCW's Department of Computer Science [4]. In this survey, local and regional employers were asked what specific computer skills were needed by all entry-level employees. Employers were provided with an existing list of computer skills. The list was compiled from the skills identified by ISOM's survey as well as those identified by the first Conference on Information Technology Curricula (CITC) in 2001 [5]. Table 2 provides an alphabetical list of the identified skills.

Companies are finding they need employees with computer skills to remain competitive. Companies are faced with having to rely upon a smaller, skilled workforce (as the "baby boom" generation ages and retires) as well as finding ways to use technology to aid their businesses [6]. Although the expectations are for a smaller workforce, employment projections for the U.S. between 2000 and 2010 show an increase of 22.2 million people [6]. Most of the employment will occur in positions dealing with computer and/or data processing areas. Much of the increase in these two areas (1.8 million jobs) stems from the need for companies to update new computer systems and to meet the Internet expectations of their clients. Of the thirty fastest-growing jobs, one-third are related to computers [6].

Table 1. Computer Information System Knowledge Needs: Current Employees and Hiring Expectations

Topics	Current employees	Expected number of hires 2003-2004: Entry level	Expected number of hires 2003-2004: One to two levels above entry
Database	1.8	0.4	0.4
Graphics design	1.4	0.6	0.3
Help desk	3.4	1.1	0.9
Networking	2.8	1.0	0.3
Programming	6.8	1.3	0.8
Systems analyst	4.0	0.7	0.5
Technical	6.8	0.8	0.5
Web development	1.6	0.5	0.5

Employers, regardless of their area of work, believe that the lack of IT skills within their workforce is a threat to U.S. global competitiveness [7]. Since a company's workforce no longer has to live within an easy commuting range of the office, with the use of communication technology, employees can live virtually anywhere [8]. If the U.S. has a shortage in skill workers, companies can look outside the country's boundaries for the requisite skills [9].

Table 2. Computer Skills Needed by Entry-Level Employees

Topic
Database
Data security and privacy
Digital communication
Graphics design
Help desk
Human-computer interface
Networking
Programming
Software
Systems analyst
Technical
Web design and development

As the use of technology continues to increase and change the work setting, employees must learn new technologies to maintain their current positions. Basic skills for using the technology are becoming a standard job requirement [10]. The entire company must become a learning organization. Employees, and hence the company, must remain flexible and able to respond to new

technological demands and needs [6]. To remain competitive, a company (and its employees) must be able to respond more quickly than its competitors [6].

Options Available To Departments

For many departments, a portion of their annually allocated budget is tied, in some part, to the number of students who are enrolled in their courses. For departments that have a high number of "service" courses or courses that are used to fulfill basic electives, a decrease of students majoring in their programs may not have a drastic effect on their budgets. For computer science departments, however, a decrease in enrollments can affect their budgets.

Service Courses

For some computer science departments, increasing the number of service courses is an option. In North Carolina, students are expected to graduate with a level of computer competency. This level of competency means, at UNCW, that graduates have an "understanding of campus use policies, facility with standard applications, and awareness of legal and ethical issues." Many departments created or identified their own courses that met this need. For some of these departments, the fact that a student used a computer for email or to write a term paper meant the student had a minimal level of competent computer use.

Many departments in computer science or management information systems were looked to to provide this service to other departments. At a minimum, these departments created one course that taught computer concepts and standard computer applications such as Internet usage and Microsoft productivity applications such as Word, Excel, PowerPoint, and Access.

At UNCW, for example, an average of 28 sections of their computer concepts course (CSC 105) during an academic year, reaches approximately 1,000 students. The ISOM department offers four sections of essentially the same course during an academic year, reaching another 250 students.

There are a few other courses that could also be considered service in that they are required courses for other majors. For example, some accounting departments require their majors to take a course in programming. The number of students reached by these service courses are small, almost negligible, when compared to the number of students reached by the computer concepts course.

Expanding the Audience through the Introduction of Minors

Another option for computer science departments is the introduction of minors that require students to take courses in the computer science department. Two minors that are popular and attracting students to computer science courses are Information Technology and Computational Sciences. The Information Technology minor is known by many names besides IT. It can also appear as Information Systems and Information Literacy.

Information Technology Minor

What constitutes an IT minor is different for virtually every IT minor that has been developed. To aid in understanding what might constitute an IT minor, the definition of Information Technology must be understood. The definition of IT comes from a site dedicated to understanding computer terminology. IT is a term that encompasses all forms of technology used to create, store, exchange, and use information in its various forms (business data, voice conversations, still images, motion pictures, multimedia presentations, and other forms, including those not yet conceived) [11].

The IT minors that are available can be computer science intensive or have a small amount of computer science and be an interdisciplinary minor. Since the desire is to increase the number of students enrolling in computer science courses, examples of both minors will be described.

University of Massachusetts Amherst

The IT minor at UMass is recognized as a model of an innovative interdisciplinary minor [12]. Established in fall 2002, it is an interdisciplinary minor including a variety of departments throughout the UMass system. Departments include art, computer science, English, marketing, comparative literature, biology, journalism, and forestry, among other departments. In addition, support for the minor came from all of the university's ten colleges and schools [12]. At a minimum, one required course is a computer science course with up to four computer science courses required before a student takes any elective courses.

The UMass IT minor requires completion of five courses totaling fifteen credits. Two of the courses are technical courses with a prerequisite in computer literacy. Once the prerequisite is completed, a student can choose two technical courses from two of the following categories. The first category, principles of object-oriented programming, focuses primarily on software programming with Java, Visual Basic, or C++ languages. The second category, representing, storing, and retrieving information, focuses on courses in data structures and systems analysis and design. The third category, Introduction to Internet technology or multimedia systems, focuses on Internet technologies and multimedia systems [13]. In addition, at least one course must come from a category described as broadened inquiry. These courses focus on the impact of IT, the history of IT, emergent technologies, and legal and ethical issues in IT [13].

The UMass minor is considered the forefront curriculum of the CITI program. One area that makes the UMass minor so noteworthy is the extent of the program and the range of courses included in the minor. The goal of the minor is to create IT generalists across the curriculum and, as such, is administered by an interdisciplinary group of faculty from disparate departments [13].

Nova Southeastern University

The Nova Southeastern University (NSU) minor is an interdisciplinary minor as well; however, it does not include the breadth of departments of the UMass minor. The NSU minor includes courses on IT; business; computer and information science; education, including early education; management; and philosophy.

The NSU minor requires completion of 18 credits. Twelve of those credits are constituted by four required courses, all of which are technical courses. These courses focus on current technol-

ogy, the impact of technology, the Internet, and multimedia. Three of the remaining six credits come from a broad range of courses focusing on computer programming, business, web design, databases, classroom technology, ethics, and business applications. The remaining three credits come from the completion of a student's project in the field. In many regards, this last course is a capstone course for students to engage in either original research or implement the technology they have learned [14].

The NSU minor is intended for students who wish to acquire some knowledge in IT as a complement to their major course of study. Students in this program have some flexibility in that they can focus some of their required courses on a specific area of interest. The NSU IT minor has many purposes. It allows students to solve problems with the use of technology, provides them with skills to perform research, imbues them with an understanding of the hardware and software used in their respective professions, and makes them more valuable and appealing as candidates in the job market [14].

George Mason University

The purpose of the IT minor at George Mason University (GMU) is to give students the opportunity to show they are IT literate in their chosen majors. IT literacy may have different meanings that are dependent upon the discipline. GMU's goals for the students are linked to computer literacy. Student outcomes from this minor include an understanding of operating systems, basic computer application use, information searching and retrieval, as well as programming and database knowledge. In addition, other forms of IT literacy may be required based upon the student's choice of major. This minor, however, is not intended for or available to students majoring in computer science, information technology, or engineering at GMU [15].

GMU's IT minor requires three core courses and two elective courses for a total of 15 credits. The three required courses are also technical courses. The topics include an introduction to IT, a course that teaches the fundamentals of computing (such as hardware, software, and applications), and a course in computer programming. The elective courses come from a broad array of departments, including computer science, decision science, electrical and computer engineering, geography, government, information sciences, math, and music. This list of elective courses is frequently reevaluated [15].

Students must identify a focus for their minor that is different from their choice of major study. If there are more than two courses that will be used for both the major and minor studies, students must identify these courses and seek approval to include them before their minor course of study [15].

University of Minnesota

The minor at the University of Minnesota (UofM) is also an interdisciplinary minor that includes four schools at the institution. The core courses come from the Institute of Technology (the school for science and engineering at UofM) and are computer science courses. The elective or breadth courses come from the College of Human Ecology, the College of Liberal Arts, and the College of Architecture and Landscape Architecture. The primary intent of this minor is to provide technical skills and knowledge to students in nontechnical fields of study [16].

The remaining credits of this minor come from a variety of courses. Courses from the Department of Communication Studies focus on electronic media and communication and courses from the Department of Design, Housing, and Apparel include the digital environment; interactive media, including animation, sound and video; and illustration. English composition courses focus on electronic texts. Geography courses focus on GIS or geographic information science. Finally, journalism courses focus on mass communication [16].

University of North Carolina Wilmington

The IT minor at UNCW was developed after a study to compare other IT minors was conducted. This minor is an interdisciplinary minor that requires three computer science courses as part of the core courses. Students are required to take a course in the Fluency of Information Technology, a course in programming, and one other computer science course of their choosing.

The fourth required course is a course from the library. This course was created specifically for this minor and focuses on the use of computer technology to conduct research.

The remaining two courses come from a variety of courses from other departments. Courses involving computer technology as a component of the course (and not as a mode of instruction) were included in this minor.

The popularity of this minor is already evident. Although the minor does not officially start until Fall 2005, several students already are working to complete the minor. Several others have delayed graduation for another semester so that they will graduate with the minor [4].

University of Arkansas Little Rock

The IT minor at UALR was developed after a study was started to create an engineering program at UALR. During the development process of the engineering program study, members of the study committee met with other educational institutions that focus on technology, such as Michigan Technological University and George Mason University. In addition, the committee met with business, industry, government, and education leaders to discuss the possible engineering program. A major outcome of the study was the recommendation for integrated computer technology in the proposed engineering program. Based upon this recommendation, UALR's chancellor requested the development of the IT minor [17].

Course requirements for the UALR minor are minimal. Only three courses constitute the minor; however, students must complete 30 credit hours before applying for the IT minor. Students must also identify how the minor would complement their academic major. All three courses are technical courses [17].

University of Connecticut

The University of Connecticut (UConn) developed its minor in response to the demand for employees with IT capabilities. This minor, however, is specifically for engineering students and focuses more on the computer science side of IT. General topics covered by the curriculum for this program include algorithms, software engineering, and numerical methodologies for solving problems [18]. All courses are computer science or engineering courses.

Computational Sciences Minor

What constitutes a computational sciences minor is also difficult to identify. There are very few of these minors or majors available; most programs in computational science are graduate-level programs. Computational science is usually defined as the use of computer science as a part of scientific investigations [19]. It also tends to be an interdisciplinary program [20].

The development of a computation science minor would incorporate other sciences, such as physics, chemistry, biology, and engineering. It could also include the social sciences, such as psychology. The idea behind this minor would be to apply computational methods. Students would use this minor to further their research and to find solutions to problems. It is an applied science program; not a theoretical science minor.

Computational science expands the use of computers outside of computable processes and structures to the application of computer processes to further science research. This is the new area of computer science…yet to be developed and designed. Yet to be fully defined.

For examples of the value of this program, look at the growth of biotech fields, bioinformatics, computational chemistry. In a quick search of job websites, these are expanding fields. At Hire-Health.com, a search for "bioinformatics" produced five hits. A search of Monster.com produced 138 hits. A search of "biotech" produced more than 1000 hits.

Why aren't there more minors in computational science? Computer science faculty like to focus on "pure" computer science or the study of computable processes and structures. A review of computer science courses available at several institutions shows that the course offerings do not change to a large degree. The biggest change for many departments was the switch from one programming language to another. Non-traditional courses are slowly making their way into the curriculum, but not without a fight. From informal discussions with computer scientists from around the country, the question of whether courses such as computer graphics , computer animation, and Macromedia programs (such as Flash and Action Script) is "pure" computer science continues.

Conclusion

There are ways to increase student participation in computer science. More students can be recruited to the program; however, based on National Center for Education Statistics, the number of students enrolling in computer science will decrease over the next decade.
Departments can offer service courses. These courses, however, are time- and labor-intensive. Still, they are necessary. Students need computer skills and must have a level of computer competency to effectively compete for jobs. And computer science departments need students enrolling in their courses. With the high demand for technological skills and society's reliance on computers, now is not the time for computer science departments to lose funding and slowly disappear.

In addition to offering service courses, departments could expand their student base through the offering of minors that incorporate other computer science courses. From a review of IT minors,

many of the "other" or elective courses used in conjunction with the minor are liberal arts or non-science courses. This is a minor that provides computer skills to students in the humanities. The computational science minor provides computer skills to students in the sciences. Students who graduate and plan to work in the sciences will probably need computer knowledge to perform their jobs effectively. Computational science courses provide that knowledge and experience specific to the students' majors.

References

[1] National Center for Education Statistics. (2003). Retrieved April 20, 2005, from http://nces.ed.gov/programs/digest/d03/tables/dt003.a sp

[2] Vesgo, J. (2005, May). Interest in CS as a Major Drops Among Incoming Freshmen. *Computing Research News 14*(3).

[3] Janicki, T. N. (2003). *Summary of survey to date.* Retrieved May 2, 2003, from http://tomj/survey/survey3.asp

[4] Patterson, L. J. (2005). *Development of an Interdisciplinary Information Technology Minor at a Major University.* Unpublished doctoral dissertation, Nova Southeastern University.

[5] Thomson Course Technology. (2004). Super major! *I.T. Link, 3*(1), 3-7.

[6] Goldberg, B. (1999). *Overcoming high-tech anxiety: Thriving in a wired world*. San Francisco: The Jossey-Bass Business and Management Series.

[7] Office of Science and Technology Policy. (2002). Networking and information technology research and development. Supplement to the President's budget for FY 2002. Washington, DC: National Science and Technology Council.

[8] Knoke, W. (1996). *Bold new world: The essential road map to the Twenty-First Century*. New York: Kodansha International.

[9] Galbreath, J. (1999, November-December). Preparing the 21st century worker: The link between computer-based technology and future skills sets. Educational Technology, 39(6), 14-22.

[10] State University of New York, Albany. (2001). I.*T. in the workplace: The impact of information systems technology on the education and training needs of hospital workers in New York City.* New York: State University of New York, Albany.

[11] TechTarget Network. (2004b). *Look it up*. Retrieved March 29, 2004, from http://whatis.techtarget .com/definition/0,,sid9_gci212591,00.html

[12] The Reinvention Center. (2004). *Envisioning undergraduate education at The Reinvention Center*. Retrieved August 2, 2004, from http://www.sunysb.edu/reinventioncenter/index.html

[13] University of Massachusetts Amherst. (2001). *The information technology program at UMass Amherst*. Retrieved August 2, 2004, from http://www.umass.edu/ itprogram/

[14] Nova Southeastern University. (2004). *Information technology minor*. Retrieved August 2, 2004, from http://www.undergrad.nova.edu/MST/itminor/index.c fm

[15] George Mason University. (2003). *GMU catalog 1998-1999: Minor in information technology*. Retrieved May 6, 2004, from http://ite.gmu.edu/degree/it_minor.htm

[16] University of Minnesota. (2003). *Information technology minor: Institute of technology.* Retrieved May 6, 2004, from http://www.catalogs.umn .edu/ug/it/it20.html

[17] University of Arkansas. (2002). *IT minor @ UALR*. Retrieved August 3, 2004, from http://itech.ualr.edu/it_minor.shtml

[18] International Conference on Computational Science. (2003). *International Conference on Computational Science.* Retrieved April 20, 2005 from http://www.science.uva.nl/events/ICCS2003/

[19] University of Illinois at Urbana-Champaign. (2005). *Computational Science and Engineering*. Retrieved April 5, 2005 from http://www.cse.uiuc.edu/