Meeting Computing Curriculum Challenges: A Profile of the Indiana University South Bend Informatics Program

Ruth Schwartz, Hossein Hakimzadeh, James Wolfer
Department of Computer and Information Sciences / Informatics
Indiana University South Bend
South Bend, Indiana
{ruschwar, hhakimza, jwolfer}@iusb.edu

Abstract

Computing as a student major-of-choice is undergoing a serious transformation. Perceptions of globalization and outsourcing appear to influence career choice as outlined by the ACM Job Migration Task Force. As a result, students must be prepared to work in domain specific environments with competence and agility early in their careers. Indiana University has provided nation-wide leadership toward educating students for this new reality through the establishment of the School of Informatics, which embraces computing along with an emphasis on interdisciplinary, domain-specific programs. The Indiana University School of Informatics initiated the first Informatics Ph.D. program in the United States, and has recently absorbed computer science as one component of its broader mandate. In this report we profile the Informatics program as implemented on the Indiana University South Bend campus. This includes its relationship with the School of Informatics and with the Computer Science department on our campus. We also describe the interface with cognate areas such as biology, sociology, health, and the fine arts. The process of implementing a cross-curricular interface is not trivial, resulting in varying degrees of cognate integration, as well as challenges for faculty. Faculty challenges include recruitment, placement, and evaluation. In summary, we survey the informatics degree requirements, cross-disciplinary implementation challenges, and faculty/tenure issues.

1. Introduction

Perceptions of globalization and outsourcing appear to be influencing career choice by prospective computing students [1]. With this emerging globalization, students must be prepared to work in domain specific environments with competence and agility early in their careers. This new reality in the IT community has been discussed at length in the literature, and this short review will serve to put the Indiana University South Bend response to these challenges in context.

One response, Swayne et.al. [2], profiles an attempt to create an “offshore-resistant” degree program, later expanded into a general framework for revitalizing Computer Science education[3]. While acknowleging that outsourcing is a serious phenomon,

they assert that the decline in CS enrollment is based on the misconceptions that today's situation projects into the future, and that CS is equated to programming. Most job-related surveys and educational assessments [4-6] list various IT occupations in hot demand for the next ten years and the following items for revitalizing CS education:

- Offer multidisciplinary and cross-disciplinary programs
- Fix computing sciences image to involve more than programming
- Move toward a BA program to allow more options in coursework
- Increase women's enrollment in CS
- Train high school computing science teachers
- Make CS courses fun

More recently, the ACM Job Migration Task Force [7] reflected these observations. Key findings indicate that offshore outsourcing of software development will continue to grow and to stay competitive countries "must adopt policies that foster innovation." These policies include strong education and training, investment in research, and the elimination of barriers to talent flows. Educational recommendations include:

- Evolve the curriculum at a pace and way that embraces changing IT
- Create a curriculum that prepares students for the global economy
- Teach students to be innovative and creative
- Find a better balance between foundational knowledge and business/application domain knowledge
- Ensure the educational system has good technology, curriculum, and teachers

Given these trends in computing, we envision the near-term computing landscape for our students to include working with smaller companies, developing vertical applications, and integrating existing technology into custom solutions to local needs. This, in turn, offers a real opportunity to students who develop entrepreneurial skills, who are agile learners and are able to keep track and pace with the prevailing development technology. In short, we envision greater opportunities for students who are highly self-motivated, and who possess domain specific application expertise as a value-added component of their education.

We also expect that much of the projected growth in computer and technology related jobs will not be strictly in technical areas, such as hardware and software development, but will include the skilled application of powerful software technology in other disciplines such as life sciences, medicine, psychology, biology, the arts and humanities. The balance of this work describes our response to these challenges, organized as follows: Section 2 describes the informatics program as implemented at IU South Bend, including our administrative and curricular profile. Section 3 briefly highlights the structure and importance of cognates within the informatics program. Section 4 discusses some of the implementation and operational challenges of managing an interdisciplinary program, and finally we will discuss some of our future goals for the informatics program at IU South Bend.

2. Informatics at IU South Bend

Through the establishment of the School of Informatics, Indiana University has provided nation-wide leadership toward educating students in the dynamic IT landscape. Informatics embraces computing along with an emphasis on interdisciplinary, domain-specific programs. The School of Informatics initiated the first doctoral program in Informatics in the United States and has recently absorbed computer science as one component of its broader mandate. As one campus in the IU system, IU South Bend also is taking part in the development of the Informatics program.

Specifically, the undergraduate program at IU South Bend is also the outgrowth of the Informatics program initially developed on the IU Bloomington campus. Beginning with an informatics minor in the autumn of 2002 with approximately six students, the program in South Bend has grown into a full undergraduate program encompassing an Informatics core curriculum with eight domain-specific cognate areas at various stages of development. Currently, the program has approximately 40 students and has added 5 new faculty members.

2.1 Administrative Profile

The administration of Informatics at Indiana University has both local and centralized aspects. For example, since the School of Informatics is a university wide school, issues regarding curriculum are discussed and approved centrally. Once the curriculum is approved, all five IU campuses hosting an Informatics program (IU Bloomington, IUPUI, IU South Bend, IU Southeast, IU Kokomo) follow the same core curriculum. This allows maximum flexibility for students who wish to transfer between IU campuses. At IU South Bend, almost all other issues are handled locally by the Informatics program director and the administrative staff in Computer Science. These issues include hiring, scheduling, implementation of new cognates, and faculty tenure.

Although the School of Informatics handles most curricular issues, not every Informatics program is housed in that school. IU South Bend, for instance, placed the Informatics program in the Department of Computer and Information Sciences which is, in turn, a part of the College of Liberal Arts and Sciences. IU South Bend made this choice to ensure that an infant program would have the resources to survive the initial startup. As Informatics expands to other IU campuses, each unit will assess its own administrative profile based on local concerns such as budgetary constraints.

2.2 Curricular Profile

The Informatics Major requirements reflect the combined goals of a solid liberal arts education, an emphasis on communication and business, a solid computing foundation, and competence in a specific application domain.

2.2.1 General Requirements

- General requirement include Fundamental Literacies:

    - English composition, critical thinking, oral communication, visual literacy, quantitative reasoning, information literacy and computer literacy.
- Common Core:
    - The natural world, human behavior and social institutions, literary and intellectual traditions and art, aesthetics and creativity.
- Contemporary Social Values:
    - Non-Western cultures, diversity in U.S. society, health and wellness.
- World languages
- Physical and life sciences
- Mathematics.

2.2.2 Informatics Core

The Informatics core is designed to provide a working foundation that builds the necessary skills for integrating domain-specific knowledge. The core consists of:

- Introduction to Informatics
- Mathematical Foundations of Informatics
- Social Informatics
- Information Infrastructure I, II (Computer Programming)
- Information Representation
- Two of:
    - Human-Computer Interaction
    - Organizational Informatics
    - Multimedia Art and Technology
    - Distributed Systems and Collaborative Computing
- Two electives ranging from Artificial Intelligence to Computer Ethics

Each student is also required to take either: "Design and Development of an Information System I, II" or "Senior Thesis I, II". These courses are specifically designed to enhance the hands-on and real-world skills of our graduates.

2.2.3 Informatics Cognates

In addition to the Informatics core, each student must complete the requirements in a cognate area. Currently approved cognates include Bioinformatics, Cognitive Science, Computer Science, Decision Science/Business, Electronic Music, English/Technical Writing, New/Digital Media, Mathematical Sciences, Computational Physics, and Sociology. These cognates are not simply minors, but are carefully crafted to provide foundational coursework at the intersection of the student's computer expertise and the domain-specific application expectations. For example, the Cognitive Science cognate includes coursework from philosophy, scientific reasoning, artificial intelligence, cognitive psychology, and neuroscience. A student pursuing a Bioinformatics cognate would supplement the core curriculum with coursework such as Molecular Biology, Genetics, Bioinformatics, Biomorphic Computing, Artificial Intelligence, and Database Systems. To the extent that existing coursework and expertise were appropriate to this objective they were adopted. When necessary new courses were developed and domain-

specific faculty were invited to join the university. To date, the program has attracted faculty in such areas as social informatics, bioinformatics, databases, software engineering, and information security. It is our goal to recruit additional faculty in the area of life sciences such as health and medical informatics as well as new media and digital arts.

3. Implementation and Operational Challenges

With any new program there are challenges and opportunities to address. With a fundamentally interdisciplinary program such as Informatics the organizational challenges are amplified. Curricula, organizational structure, governance, funding, and inter-departmental communication pervade the day-to-day decision and implementation process. The primary academic challenge unique to this type of program is defining the appropriate set of cognate courses. Each participating department works closely with the Informatics director to establish curricula consistent with the credits available in the Informatics program and the rigor required by the cognate discipline.

From an administration standpoint interdepartmental challenges and concerns include:

- Concern over the definition of Informatics and how it applies to any given cognate area. This concern is not unique to this program, but is common in emerging disciplines. A good example is the emergence of Bioinformatics which struggles to define the content that distinguishes it, the relative role of its constituent contributors, and even its place for faculty. That is, is Bioinformatics fundamentally Biology or Computer Science?
- Concern that Informatics as a discipline constitutes a fad, and therefore, will not be an enduring investment for the future. All new disciplines face this challenge, historically including Computer Science and, more recently, Software Engineering. Ultimately this will be ascertained only in retrospect. That having been said, we believe that Informatics will endure in one form or another since it fundamentally deals with enhancing the information infrastructure across the intellectual landscape, and is firmly anchored in computing fundamentals.
- Concern that participation with the Informatics program will constrain departmental autonomy. This is exacerbated when faculty salaries are shared between the "home department" and Informatics. Since participation by departments is completely voluntary, this has proven to be less of a concern in practice than in anticipation. It is something that must be discussed with newly-forming programs.
- The pragmatic concern over funding. For example, which portion of a cognate faculty appointment participating in the Informatics program should be funded from the Informatics budget and which should be funded from the cognate department? This concern is ongoing, and is currently being addressed through case-by-case negotiations based on the proportion of effort expended in each area.

3.1 Faculty Issues

Operating an interdisciplinary program creates some unique issues for faculty as well. In addition to the departmental funding mentioned above, faculty concerns include:

- Recruitment and retention. One of the most important tasks performed by an academic unit is recruitment and retention of quality faculty. Under the best of circumstances, this is a challenging task however; an interdisciplinary program poses its own unique challenges. For example, faculty members recruited for our program often require two or more departments (sometimes crossing college boundaries) to cooperate with each other to develop a search and screen process, fund, recruit, hire, house, and review the faculty.

- Departmental Housing. Faculty members must be placed in a location that satisfies both university needs and career goals. A faculty member teaching bioinformatics, for example, could be housed in Informatics, Computer Science, or Biology depending on program goals and faculty expertise. Given our good relationship with other academic units on our campus, we have adopted a model which houses informatics core faculty in the department of Computer Science and Informatics, and houses cognate faculty in the department which is closest to their core discipline. This model provides the flexibility to accommodate both individual faculty and program needs.

- Tenure. Traditionally an individual is recommended for tenure based on the assessment of their department. For a faculty member participating in an academic hybrid program this becomes more difficult since institutional policies don't always anticipate these circumstances. At the minimum, faculty members should be housed in the department representing their dominate expertise, with provision for additional input from colleagues in Informatics.

- Evaluations. Related to tenure, faculty members are evaluated on an annual basis. These evaluations traditionally reflect the department chair's assessment. In an Informatics program evaluations also should reflect input from the director. Currently, we have two members of the faculty who are being evaluated by Computer Science, one by Sociology, and one who is evaluated jointly by Biology and Computer Science.

These items represent only a sample of the challenges. As with any program new concerns and opportunities emerge over time, policies are refined, and the cycle is repeated.

3.2 Student Profile

The School of Informatics reports that [8], statewide, there are 1250 students working toward a BS in Informatics or Computer Science. At the IU Bloomington campus, there are 382 students majoring in Informatics and 135 students in Computer Science, representing a 3 to 1 ratio. On the IU South Bend campus, there are currently 40 students majoring in Informatics and 175 students in Computer Science. We note that, at present, the student interest at IU South Bend is 4 to 1 in favor of Computer Science, however during the past three years Computer Science has been on a downward trend and Informatics has been growing. At IU Bloomington, approximately 12.5% are woman,

and 8% are international [8]. These numbers track closely at IU South Bend. The average starting salary for our IT majors is approximately $42,000.

3.3 Gender Issues

As indicated above, only 12.5% of students in our IT programs are women. Unfortunately, this statistics is repeated nationally by many Computer Science, Computer Engineering and Informatics programs [9, 10]. Computer Research Association (CRA) report on Recruitment and Retention of Woman in Computer Science and Engineering [11] indicates that "As computing technology becomes increasingly pervasive, this under-representation translates into a loss of opportunity for individuals, a loss of talent to the workforce, and a loss of creativity in shaping the future of society."

It is our hope that the Informatics program, with its emphasis on interdisciplinary educational opportunities, will serve as a vehicle to increase recruitment and retention of woman to technology and scientific disciplines.

3.4 Curricular Challenges

Creation of a new program raises many challenges; dealing with a new interdisciplinary program raises additional challenges. At IU South Bend, the Director of Informatics has just completed the first program review. This process identified several challenges for the program.

The curriculum created by the central IU School of Informatics forms the basis for our program. However, when implementing the program we did not give sufficient attention to the differences in the make-up of the student bodies. Most of the students in Bloomington and Indianapolis, the main campuses of the School of Informatics, are full-time students who live on campus and meet above average entrance requirements. IU South Bend serves a more diverse student population consisting of commuter students, many of whom are considered non-traditional. Many of these students work a minimum of twenty hours per week while attempting a full course load to maintain financial aid.

Many of our students also exhibit deficiencies in mathematics, science and computer science. We are investigating the possibility of requiring prerequisites to the first major course, Introduction to Informatics. Courses under consideration for this prerequisite include an introductory course covering computer concepts and productivity tools, an introduction to programming logic, and an introduction to operating systems. We also are considering making our first mathematics course, Finite Mathematics, a co-requisite to Introduction to Informatics, thus forcing students to have a minimal level of math proficiency before beginning the program. Finally, we are advising majors to start their science requirements early in their program rather than allowing them to defer an area where they may be deficient.

3.5 Relationship with Cognate Departments

The original formation of the cognate curriculum was an ad hoc activity. The Informatics committee chose cognates based on the model formed at the IU Bloomington School of Informatics with minimal attention to local needs. In practice, cognate department heads

met with committee members to suggest existing courses and new courses that could be used to build a cognate in their area. After accepting several Informatics majors, working with them on their cognate choice, and conducting exit interviews shortly before graduation, several issues came to light.

Specifically, we need to revisit each cognate and make sure the prerequisite courses are appropriate for our students who are in class with students majoring in the cognate area. Some of the students felt they were deficient in certain areas. We also need to make sure that some if not all of the courses have a technology component so the informatics students can use their major skills. We also need to develop additional cognates. As new students enter the program we must be malleable enough to quickly develop a new cognate if that is where their interests lie. One of our main goals is to produce graduates who can apply technology in other disciplines which we believe is the strength of this interdisciplinary degree.

3.6 Refinement of Minor

Our program started with the introduction of an Informatics minor. This was done anticipating the conversion of these students to majors once the state of Indiana approved and funded our bachelor's program. Now there is a new thrust on campus to require students receiving a BA degree from the College of Liberal Arts and Science to complete a minor to complement their major. We feel that Informatics is a perfect choice as it will make these students technically savvy and give them the interdisciplinary expertise that is the underpinning of this new requirement. We need to review our minor course of study to make sure it meets the requirements of the College.

4. Future Goals

With any new program, the leadership always must address future goals and objectives. These goals are constantly changing as some goals are met and new ones arise. Currently our goals include addressing curricular challenges, our relationship with cognate departments, refining our minor, and the possibility of adding a graduate degree.

Currently our assessment plan is in its infancy, refining and evaluating a comprehensive assessment plan for the core as well as cognate areas of informatics is an important goal that we are working toward.

Establishing a graduate Informatics program on our campus is a distant goal. Before we seriously consider this goal, we must strengthen our undergraduate program and increase the number of majors and minors. We also must make sure that the other departments and schools at the university will support our endeavor for an interdisciplinary graduate degree.

5. Summary and Conclusion

Undoubtedly, the effects of globalization [12] on economic, social and educational systems have been profound. According to Tom Freidman [13], our students have to

compete with students from other nations in a "Flat World" where the web technology, supply chain, open-source software, out-sourcing, and off-shoring have leveled the playing field. These factors as well as the rise and fall of "dot" companies in the late 1990's, appear to have negatively impacted students perception of IT disciplines as the next wave. Therefore, many computer science departments have experienced a plummeting of student interest in their programs. Ironically, at the same time the employer needs for technically adept employees continues to rise.

Fortunately, professional computer science and computer engineering organizations such as ACM, IEEE and CRA have engaged in brainstorming this issue, targeting and creating outreach programs for K-12, women, and minorities. The National Science Foundation also has increased funding to promote Science, Technology, Engineering, and Mathematics (STEM). Universities also have started to react, attempting to develop new programs and produce students with skills that are less susceptible to out-sourcing.

Indiana University has been at the forefront of this movement. By creating the School of Informatics in 2000, Indiana University has provided nation-wide leadership toward educating students for this new "Flattened World". The School of Informatics distinguishes itself from traditional IT programs by embracing computing along with an emphasis on interdisciplinary, domain-specific cognates. Yet another bold move by the school has been its recent absorption of computer science as one component of its broader mandate. Furthermore, it has initiated the first Informatics Ph.D. program in the United States.

Although Informatics at IU South Bend is in its infancy, it has already attracted over 40 majors, it has attracted significant state funding during a time of fiscal difficulties, it has recruited a number of new faculty in areas such as bioinformatics, social informatics, software engineering, databases and computer security, and finally, it has created a number of cognate programs by forming partnerships with other academic units on our campus. We believe that this interdisciplinary approach to computing education offers a valuable avenue for students entering the computing discipline and represents a future growth area in information technology.

References

[1] Foster, A. L., Student Interest in Computer Science Plummets, Technology companies struggle to fill vacant positions, Chronicle Of Higher Education, Volume 51, Issue 38, Page A31, http://chronicle.com/free/v51/i38/38a03101.htm

[2] Swayne, D.A., Mahmoud, Q. H., Dobosiewicz W., An Offshore Resistant Degree Program. IEEE Computer. August 2004: 102-104.

[3] Mahmoud, Q. H., Dobosiewicz, W., Swayne, D. A., Making Introductory Computer Programming Fun and Accessible. IEEE Computer. February 2004: 106-108

[4] U.S. Department of Labor, Bureau of Labor Statistics, Occupational Outlook Handbook 2006-2007 Edition.

[5] CRA Report. Taulbee Survey, Computing Research Association, http://www.cra.org/statistics/

[6] Allen Tucker, A Model Curriculum for K–12 Computer Science: Final Report of the ACM K–12 Task Force Curriculum Committee, October, 2003, http://www.csta.acm.org/Curriculum/sub/k12final1022.pdf

[7] Aspray, W., Mayadas, F., Vardi, M. Y., Job Migration Task Force, Globalization and Offshoring of Software, A Report of the ACM Job Migration Task Force, http://www.acm.org/globalizationreport/

[8] Informatics, and Computer Science Fact sheets. Indiana University, School of Informatics, http://www.informatics.indiana.edu/employers/informatics-students05.pdf, http://www.informatics.indiana.edu/employers/cs-students05.pdf

[9] Camp, T. "The Incredible Shrinking Pipeline," Communications of the ACM, 40(10), pp. 103-110. (1997)

[10] Cohoon, J.M. (1999) "Departmental Differences Can Point the Way to Improving Female Retention in Computer Science," SIGCSE Bulletin 31(1), pp. 198-202.

[11] Cuny, J., Aspray, W., Recruitment and Retention of Woman Graduate Students in Computer Science and Engineering, Report of Workshop, CRA, June 20-21, 2000. www.cra.org/reports/r&rwomen.pdf

[12] Friedman, T. L., The World Is Flat, A Brief History of the Twenty-First Century, Published by Farrar, Straus and Giroux, April 2005.

[13] Pink, D. H., Why the World Is Flat, Wired Magazine, http://www.wired.com/wired/archive/13.05/friedman_pr.html

Biographies

RUTH B. SCHWARTZ is Associate Professor of Computer Science and Director of Informatics at Indiana University South Bend. She earned her Ph.D. (Business Administration, Temple University, 1993). Her research interests include curriculum development, database systems, ERP, and programming languages.

HOSSEIN HAKIMZADEH is Associate Professor of Computer Science and Chair of Computer and Information Sciences at Indiana University South Bend. He earned his Ph.D. (Computer Science, 1993) from North Dakota State University. His research is in the area of database systems and object oriented software engineering.

JAMES WOLFER is Associate Professor of Computer Science at Indiana University South Bend. He earned his Ph.D. (Computer Science, 1993) from Illinois Institute of Technology. His research interests include naturally inspired computing for real-world problem solving, visualization in science and medicine, and computer science education.