Clarifying Computing Study Choices for the Student

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Abstract

Our discipline and profession faces a tremendous challenge. On the one hand we find that fewer students are enrolling in our programs over the last several years. Part of this trend can be attributed to the dot com failures of the late '90s and part can be attributed to the media's current infatuation with outsourcing of technical jobs. On the other hand the number of courses of study that are available as choices to high school students in the computing professions has grown from a single choice (computer science) to seven or eight different courses of study. Most laypersons understand a career in computing to be "computer science." If you are in "computer science" there is a general belief that the primary job duty will be programming. Programming is not viewed as a very positive career choice due to the current perceived outsourcing trends. For that reason it behooves us to explain to prospective students what their study and career choices can be in computing in a way that attracts students to our profession. This paper defines the problem in terms of its characteristics and describes one approach to providing high school students a model for understanding the choices they have today in computing.

Keywords: Computer Science, Information Systems, digital media, Computer Engineering, Software Engineering, Management Information Systems, program selection

1. INTRODUCTION

Our field of study and profession is getting more diverse and more specialized with respect to the subject matter that it spans. This may be a sign of evolution and/or maturation, but fundamentally it is also a sign of complexity. For those of us in post-secondary education who specialize in Computer Science or Information Science, the challenge is to demystify the complexity so that high school students can make the appropriate choices when entering college. In some cases, the number of computing related fields that a student can choose can be daunting. At Drexel University for example, there are currently six computing-related programs of study with a seventh in the making. The programs of study at Drexel, most of which are degree programs, include, Computer Science, Information Systems, Software Engineering, Management Information Systems, Digital Media, and Computer Engineering. How do you explain this landscape of choices to students whose primary exposure to computers may have been an AP programming class, a network certification class, video games, and the messages the media provides? Fundamentally a junior or senior in high school will see a career in computing as primarily having something to do with programming or worse, as something involving spending most of one's time sitting in front of a computer screen. For parents, the problem of understanding our field is even more daunting because many are still of the generation where computers came "on the scene" during their careers. Their exposure to them may only be through applications (like a word processor) and programmers (who they may have had to interact with at work). If students and parents potentially view a computing career as "programming" and if the media focuses on "programming jobs moving offshore" we have the conditions to cause many students to choose other career paths. As educators we need to get the word out that a career in computing is not just about programming, and in fact it is a career affording tremendous opportunity.

One way to begin the process of demystification of the fields of study is to look to the field for help with defining the various disciplines. From Reichgelt, et al (2004), we have the following definitions –

Computer Science –

"Computer Science is the study of the design and properties of algorithms, and their linguistic and mechanical realization."

Information Systems –

"Information Systems as a field of academic study encompasses the concepts, principles and processes for two broad areas of activity within organizations: (1) acquisitions, deployment, and management of information technology resources and services and (2) development, operation, and evaluation of infrastructure and systems for use in organizations processes."

Information Technology –

"As an academic discipline, information technology focuses on meeting the needs of users in an organizational and societal context through selection, creation, application, integration and administration of computing technologies."

If we were to ask academics and professionals in these fields to consider these definitions we would invariably have discussion and perhaps even significant differences. But more importantly, the question of whether these definitions resonate with young students making college and career decisions is extremely important. Do the definitions sufficiently represent what a person would be doing in a particular field? One of the issues we face in clarifying these various disciplines is to define the computing fields in such a way that the definitions are at once accurate and also can be related to by students.

In the study entitled "Joint Venture's 2002 Workforce Study" (2002) carried out by A.T. Kearney for the Silicon Valley Joint Venture we see some evidence of the lack of awareness of high-tech careers in a geographic area where technology represents a significant percentage of the available career opportunities. From this study, "student awareness of high-tech careers lags behind their awareness of more traditional careers," and "32 percent of the students surveyed plan to pursue technology- or computer-related careers." Given the forecasts of career opportunities over the next ten years we can see that we will not have the necessary workforce to fill the available technology-related jobs.

We can also look to the research on diversity in our field specifically as it relates to female students wishing to take up a career in computing. Harris and Wikinson (2004) point out that culturally influenced perceptions of computing will tend to influence students entering into the field. Thus, if computing is primarily seen as a male-dominated career choice, this may dissuade women from entering the field. Chan et al (2000) think that misunderstandings about the nature of a career in computing contributes to student's not gravitating towards computing as a career.

2. TRANSFER STUDENTS

Transfer students represent one of the indicators that we believe is a symptom of the lack of understanding of the different options that students have when selecting a computer-related major. Historically we will see a significant number of students immediately (by the second college term of freshman year) change their programs of study from Computer Science (CS) to Information Systems (IS). When asked why students are making this change, the answer is more often than not that CS involves too much programming or too much math. In fact we find that many IS students are quite reticent about taking programming courses at all (even though this is a basic requirement of both CS and IS curriculums). Clearly it is important to get students to understand that a key aspect of CS is programming. We find anecdotally that a career in computing is so closely understood to be computer science that it is extremely important to explain that a computing career is much more than this.

Year	Transfers	New IS Freshman	New CS Freshman	% Transfer	IS % Change
AY 1999	37	87	178	20.79%	48.88%
AY 2000	46	130	216	21.30%	60.19%
AY 2001	42	118	198	21.21%	59.60%
AY 2002	63	80	161	39.13%	49.69%
AY 2003	38	42	130	29.23%	32.31%

Table 1 – 5 Year History of Internal Transfer Students from Computer Science to Information Systems

This chart shows, for the past 5 years, the number of students that transferred from CS to IS at Drexel University. In general we can see that fairly consistently at least 1 in 5 students transferred from CS to IS during this period. This amounts to a significant number of students entering the IS program. Are these transfer rates significant when compared to other programs (non CS or IS)? Looking at statistics collected at James Madison University across many programs of study major transfer rates range from 39% to 46%. Drexel's transfer rates are certainly in line with these percentages (across many different programs). Since Drexel's data reflects programs that are related to one another through their base discipline (computing) the transfer rate at Drexel begs the question, is there any way to reduce the number of students who transfer through a more concerted effort to explain the different computing disciplines? An attempt to reduce transfer rates across disparate programs would be substantially more difficult.

3. PERCEPTIONS AND BELIEFS ABOUT COMPUTER SCIENCE, INFORMATION SCIENCE AND OTHER COMPUTING-RELATED FIELDS OF STUDY

There is another, perhaps more important reason why the issue of explaining the opportunities in computing for students is an important one to address at this time in our field. Based on studies that have been done perceptions exist about our field that tend to drive students away from it. Some of these perceptions were mentioned earlier, namely, for example, "all computing jobs will be outsourced" or "most computing jobs have disappeared because of the failures of many dot.com enterprises." In contrast to these perceptions various forecasts and studies indicate just the opposite – that there will be tremendous opportunity for individuals that will choose a computing-related field as a career choice. For example, one study by the Bureau of Labor Statistics forecasts that for the next ten years the fastest growing field producing the greatest employment opportunities will be computing (http://www.bls.gov/emp/emptab3.ht).

In addition to these "economic" perceptions there are other perceptions. When considering for example why computing-related careers are not more diverse researchers uncover perceptions like computing is "boring" and the people in computing are "socially awkward." (Moody and Beise). Other opinions that have been exposed include statements like, "computer science is geeky." Computer Scientists are "not athletic." (Graham and Latulipe, 2003). If we are to attract students to the computing fields we must address these perceptions and begin to counter them with what our field actually offers as opposed to what it is perceived to offer. When students "get it" they are able to articulate statements like, "Computing is tremendously flexible – I can participate in almost any field and computers will be involved." Such a statement is a far cry from "All computer scientists do is write programs." In order to breakdown negative and incorrect perceptions we need to create viable and realistic stories that enable us to clearly articulate the opportunities. One of our vehicles for accomplishing this is designed to engage students using a technological artifact they are familiar with to better understand the computer-related fields of study.

4. EXPLAINING THE DIFFERENCES

Given that there are many different ways to explain the differences between the various disciplines, what approach may have the greatest success of getting the message across to students that might be interested in computing as a field of study?

One approach would be to provide a definition of each of the disciplines to a student. Although an accurate way of providing the necessary information, it does not go far enough in giving the student something to relate to. Generally students have several salient questions, one of the most important of which is, what would I be doing if I went into a specific discipline of computing? In essence it is important to give students a basis for comparison so that they may understand the various disciplines within a single framework.

To achieve this we have taken the approach to adopt a particular device and describe that device in terms of the various computing disciplines. In other words the question is, if I were to select a computing career in X then I would be doing Y in relation to this device. The selection of a particular device for these purposes is critical because it must also be something that the student easily relates to. Fortunately such a device has been created for us that has captured the attention of students – most students know about the iPod® and are interested enough in the device to pay attention to its description in terms of the six computing-related disciplines.

Figure 1 – The Apple iPod®

The explanation of the iPod® in the context of our field is one that can be understood by both students and parents. It is often the case that when we are presenting a description of the various fields of study we are presenting to a combined audience. Most people are familiar enough these days with electronic devices that they can relate to this device and understand how the disciplines support the creation and ongoing use of the device. For the sake of brevity the following represents an overview of each of the disciplines and its relationship to the iPod®.

Computer Engineering: Design and implementation of the processor, electronics, packaging (physical components), and other components (miniature hard disk drive).

Computer Science: Design of the algorithms that support the iPod® like audio compression/decompression algorithms used by the iPod®.

Software Engineering: The complexity of the iPod® as a computing device for the consumer forces a requirement of software reliability. An engineering approach to the development of the software for the iPod® increases the probability of the reliability of iPod's software.

Information Systems: The iPod® is a device used by human beings and it is important to consider how it will be used (Human-Computer Interaction or HCI). The iPod also maintains a store of data (database) that represents its musical and non-musical contents so there is the idea of database inherent to this device.

Management Information Systems: Systems that support the manufacture, sales, and distribution of the iPod® are under the prevue of Management Information Systems or MIS.

Digital Media: The iPod® is a digital media device and is supported by digital media. The creation of media (music) and other non-media elements (Internet sites) is the focus of Digital Media.

Based on this explanation we have provided students and parents with a way of understanding our field in terms of aspects of what student roles would be in any one discipline. Of course the disciplines are not as definitive as these characterizations make them out to be, but the characterizations do provide a view into the various orientations of the various disciplines. Based on these descriptions one view of the disciplines can be along the dimension of level of technicality.

More Technical	More People Oriented	More Business Focused
Computer Engineering	MIS	MIS
Computer Science	Information Systems	Information Systems
Software Engineering	Digital Media	Software Engineering
Digital Media	Software Engineering	Digital Media
Information Systems	Computer Science	Computer Engineering
MIS	Computer Engineering	Computer Science
Less Technical	Less People Oriented	Less Business Focused

Table 2 – Understanding Computing Disciplines as a Continuum of Various Characteristics

Of course these characterizations could also be debated. Our goal is to provide a basis for consideration of the disciplines in a reasonable fashion and to give students a vocabulary with which to understand the complex field of computing.

We originally began using this way of explaining computing disciplines as part of a presentation in which this model was used. Because we wish to "get out the word" on a wide scale basis we also created a vehicle that could be mailed to students and parents that describes the various disciplines. The piece, illustrated below consists of a folded paper "handout" a little larger than the iPod® device meant to represent a generic MP3 player. As the handout is unfolded it exposes the various computing disciplines and with pictures and words explains each of the six disciplines. The pictures serve to reinforce the various aspects of the computing disciplines.

iPod® Brochure

We wanted to develop a mailing for students and parents that would clarify the differences between the various computer careers. The idea was to create an artifact that would tell the story about computing careers in an interesting and compelling way. The brochure we created, folded, is a bit larger than the actual iPod® when folded. On the front of the brochure are the phrases,

Small Size.
Huge Undertaking.

Each panel of the pamphlet has a picture representing an aspect of the device. As the panels are unfolded an explanation is given that relates the aspect to a particular area of computing study. For example the devices that control such a device may be designed by computing professionals who study human-computer interaction – a subject studied by students of information systems. Each of the remaining areas of study is also covered in the pamphlet. We think of the pamphlet as an alternate means to explain the computing study disciplines and also a means to reinforce the presentation. Teachers, students, and parents have found the iPod® Brochure to be useful in clarifying the computing study disciplines.

5. MULTIDISCIPLINARY COMPUTING PRESENTATION

Three to four times per year Drexel University hosts open houses for high school students and their parents considering Drexel as a college selection. The open houses include presentations by the various colleges and programs of study. On this day for example, Computer Science, Information Systems, Computer Engineering, Digital Media, and Software Engineering may all give presentations. In order to address the clarification of programs of study issue, some of these open house sessions will include joint presentations that describe the various computing disciplines. This presentation is multidisciplinary and is notable because it attempts to couch the various programs of study in the context of problems that an audience of parents and high school students would understand and then present the disciplines in terms of those disciplines. The three problems that we have selected are Video-On-Demand, The Apple iPod®, and Video Game Creation. The content of the iPod ® brochure (Figure 2) was derived from this presentation.

6. RECEPTION

Of course it is important to prove that there is value in providing this information in this form and an appropriate study is warranted. Our intention in writing this paper was to describe our approach to the problem of the complexity of our field and explaining the differences in the programs of study. To date no such study has been undertaken but we are considering collecting information from the various audiences to which we present (high school students and parents).

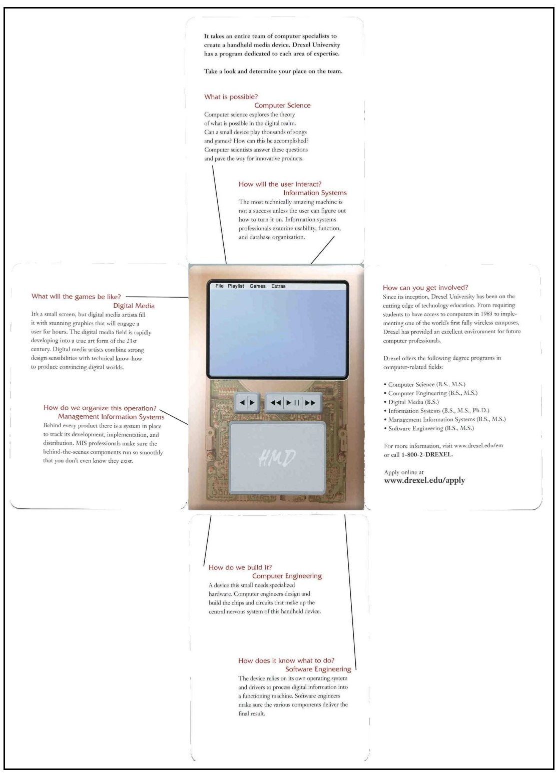

Figure 2a – iPod Brochure Unfolded

Figure 2b – iPod Brochure Unfolded

Having said this we have collected anecdotal comments that would seem to indicate the the explanation is one that resonates with parents and students. We know for example that our message is working when a student makes a major change (area of study) as a result of the presentation. We have had such occurrences. We also know that the presentation meets its goal when parents come and comment that they now understand the differences. We have also received the same comments from high school counselors.

7. NEXT STEPS AND CONCLUSIONS

To better understand the impact of our approach we propose to conduct a study to investigate the impact of using this model to demystify computing-related areas of study and careers.

Since our understanding of our target communities for computing careers is largely empirical we seek to confirm whether this understanding is, in fact, valid.

We seek to select samples of the four types of individuals shown above to understand how these groups differ in their perception about computer-related careers. Lay persons (student, adult) are individuals with minimal formal education in computing. By formal education we mean they have never taken a course or class in any computer-related skill and are not self-taught individuals. Non-lay persons (students, professionals) are individuals with formal education or experience in a computing-related career.

Upon formation of a balanced sample we would randomly divide the sample into a control group and a test group. Both groups would be asked to take a pretest that involves providing short (2-3 sentence) definitions of each computing discipline. These definitions would be scored by three(3) computing professionals.

After completion of this task the group will be given the iPod® presentation and a posttest will be given requesting the same definitions as before. The results will be scored again and the results of pretest and posttest will be compared for differences.

Ultimately we hope to confirm (or deny) the following hypotheses:

Common misconceptions exist among lay populations about computing studies and careers.
Misconceptions can be reduced by using a tangible and relatable model.

The problem of explaining computing to prospective students is one that warrants immediate attention. The demographics of new students entering relevant programs of study and subsequently entering a career in computing have dropped substantially over the past several years. This runs counter to the predictions for the need for professionals in computing. As educators we must develop educational tools to clarify and attract students to our discipline. One way to accomplish this is to make students understand how they might be involved with creating interesting, exciting, and useful technology. We have shown one approach to doing this using a "cool gadget" as the basis for our educational story. More research needs to be done about the education needed to attract students and how we might create the elements of this education to change the downward trend.

8. REFERENCES

Chan, V., Stafford, K., Klawe, M., and Chen, G. (2000), "Gender differences in Vancouver secondary students", in "Balka, E. and Smith, R. (Eds.), **Women, Work, and Computerization: Charting a Course to the Future**, Kluwer Academic Publishers, Boston, MA, pp. 58-69.

Fastest Growing Occupations, 2002-2012. Bureau of Labor Statistics. http://www.bls.gov/emp/emptab3.htm

Graham, S., and Latulipe, C. (2003), "CS Girls Rock: Sparking Interest in Computer Science and Debunking the Stereotypes." **Proceedings of SIGCSE 2003**, pp 322-326.

Harris, H., and Wilkinson, M.A. (2004), "Situating Gender: students' perceptions of information work." **Information Technology & People**, 17:1, pp 71-86.

Joint Venture: Silicon Valley Network. "Connecting Today's Youth with Tomorrow's Technology Careers," 2002 Workforce Study, with A.T. Kearney. http://www.Jointventure.org/workforce/Workforce_Final.pdf

Reichgelt, H., Lunt, B., Ashford, T., Phelps, A., Slazinski, E., and Willis, C. (2004), "A Comparison of Baccalaureate Programs in Information Technology with Baccalaureate Programs in Computer Science and Information Systems." **Journal of Information Technology Education**, 3, pp. 19-34.

Transfer Graduation Statistics. James Madison University, 1992-1995. http://www.jmu.edu/instresrch/notes/v12n2t1.htm.