NSF Workshop on Integrative Computer Education & Research: Preparing IT Graduates for 2010 and Beyond

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White Paper

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The problem

As per the workshop invitation, the problem is twofold:

1. Curriculum: The field is increasing in both complexity (depth) and breadth, making it difficult to design/maintain curricula.
2. Recruitment: Our country needs more computing graduates, yet fewer and fewer students are enrolling. This is especially pronounced for women and minorities.

What additional expertise is needed?

Part (2) is largely a social psychology problem, namely to convince more people in our society to become educated in computing. For this reason, I do not believe it is sensible to work on such a problem without involving scientists with expertise in social psychology.

Whom are we trying to reach?

"Not like us": This is a common phrase in the human-computer interaction community. The problem in that community is that people creating user interfaces (typically, software developers) are not like the users for whom the interfaces are being created (typically, not software developers). Evidence abounds that the software developers do not have a reasonable intuition as to what the intended users need in order to flourish.

The same is true in our case. The intended students are not like most of us, and hence our intuitions about what will attract them are not likely to be very accurate. For example, a large number of the people we especially want to attract are not Caucasian, not male, and not middle-aged. They were not raised in the same social era as most of the attendees at this workshop, and have not experienced the same work ethic expectations in their pre-college education.

How can we evaluate which ideas will be effective in attracting these people not like us? We must resist the temptation to conjure solutions from our own opinions, drawing instead from data and from applicable scientific theory. Fortunately, both data and applicable theory are available and/or obtainable. For example, we can draw from psychology research on motivation, self-efficacy theory, the well-documented impacts of critical mass in retaining underrepresented groups, and more. There is a growing literature as well on the needs and issues of particular underrepresented groups (e.g., [4]).

For example, there is research showing that computer science females are motivated by how technology can help other people, whereas males tend to enjoy technology for its own sake [3]. The following is from a female at Carnegie Mellon, describing why she chose to major in computer science:

> *I think with all this newest technology there is so much we can do with it to connect it with the science field, and that's kind of what I want to do (study diseases) … Like use all this technology and use it to solve the problems of science, the mysteries* [3].

Such gender differences are also are representative of other women who use technology, such as architects, NASA scientists, and filmmakers. In one study [2], women and men were asked to write a science fiction story in which the perfect technological object is described. The women described objects as tools to help integrate personal

and professional lives and to facilitate creativity and communication. The men's descriptions, however, used the technological device to increase command and control over nature and one another.

A proposal

The following is a proposal to ground the solution in science, including data gathered from the people we are trying to reach:

Step 1: Gather data from targeted middle- and high-school populations of students on what motivates them, what interests them, attributes of a career they see as important, and so on. (Note that questionnaire writing is a science, and it will be important for someone who knows that science to supervise the creation of the questionnaire.) Incorporate applicable scientific theory to interpret and understand these data.

Step 2: Change computing curriculum and recruitment to be consistent with the results. (See the next section for examples.)

Step 3: Continuously evaluate effectiveness using a variety of empirical methods, fine-tune, and repeat.

Examples of possible curriculum/recruitment follow-ups

Here is a selection of ideas that have not been tried in a serious way. There is no element of completeness of coverage here; it is assumed that these ideas, if warranted by the findings of the proposed process above, would need to be combined with other ideas too.

Encourage CS research projects that have elements of the findings for recruitment/retention/education: If findings suggest the need for more connection to society/human problems, add more computing research whose ultimate aim is to solve social/human/medical/education problems. For example, my own Gender HCI research project [1], which studies how *software* design factors interact with gender differences, has attracted numerous applications from female students at three levels—graduate, undergraduate, and high-school—who then stay in the field.

Connect the education of Computer Science with people-oriented education: If findings from the data indicate a desire to collaborate with others, our curricula could do a better job of including teamwork. Although many curricula include team projects per se, few include the techniques for project management and teamwork that would help ensure success and intellectual engagement in software teamwork.

Connect the study of Computer Science with altruism: If a finding from the data indicates a need to help others, our recruitment/retention devices could be explicit about the importance of computing to our country's welfare.

An overall "anti-goal" I'd like to stress is that I believe we should avoid "dumbing down" the curriculum, i.e., sacrificing depth to achieve more breadth. Rather, fine-grained integration along the lines of the above, is, in my opinion, an important constraint we should maintain in any solution we try.

References

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