Challenges for Integrated Computing Education and Research over the Next Ten Years
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1. Preparing undergraduates for computing careers

The most significant challenges that I face in educating computer science undergraduates can be classified in three areas: (a) misperception (b) lack of preparedness and (c) complexity and learning styles.

Misperception: Many incoming students and the public, in general, do not understand what the science of computing is all about. "I liked using Photoshop in high school, so I think I'll major in computer science" syndrome has fortunately died, but the "computer science as programming" misconception persists. Employers further exacerbate this problem by their emphasis on particular programming languages and technologies in their advertising as opposed to fundamental problem solving skills.

Preparedness: Many incoming college students are singularly unprepared in logic, mathematics, and problem solving to handle the rigors of a traditional computer science program. Reading and writing difficulties are also serious problems. Traditional high school curricula, AP courses and exams, science fairs and contests only seem to work for a small percentage of those entering American colleges and universities.

Complexity and Learning Styles: The difficulty of explaining computer science in a simple hierarchical fashion going from less complex to more complex is exacerbated by the fact that many students have learned pieces of sophisticated technologies prior to entering college without fully understanding them. Since computer science is an unusual mixture of applied mathematics, engineering, and information science, finding a balance between the abstract and concrete is difficult. Traditional engineering majors have been somewhat homogeneous in terms of Myer-Briggs learning style (concrete sequential), making it easier to design and implement curriculum; this does not appear to be true for students electing computer science as a major. Many students are coming to college with a heretofore unstudied learning style, based around "simulation and gaming".

I have discussed the above issue with respect to computer science education which is quite a bit narrower than computing education. The many new schools of information science (Cornell, Duke, Northeastern …) have been studying the issue of broader computing education for over 4 years in the CRA Academic Dean's Group. Consensus does not appear to be forthcoming.

2. Transforming the educational experience

I believe that computing education will be transformed over the next ten years as a result of paying greater attention to the following issues: (1) diversity of learning styles (including new and emerging learning styles such as gaming and simulation) and their impact on pedagogy and assessment; (2) diversity of the audience (students) in terms of culture, gender, ethnicity, economics, politics, nation, etc. (3) where and when the learning takes place (social, individual, online, in bathroom); and (4) individually-customized, agent-delivered curricula.

I believe that much of the progress will come from research advances in cognitive science behavioral science, cognitive tutors, and AI and machine learning

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3. Models for transforming computing education

Problem-oriented curricula; long-term project engagement; individualized learning plans; social and individual learning contexts; massively multiplayer online games are just some of the models that need to be considered.

4. Inhibitors and Strategies

Some of the major inhibitors are resistance to change by existing computing faculties, governmental restrictions (homeland security, jingoism), lack of federal and state funding for institutions of higher learning (many with 15% state support or less), American university environments (lack of support for innovation, resistance to change, silver bullet reliance on incubators), archaic business models, global intellectual property sharing.

Open source movement; GENI-like initiatives; Training versus education and better business models;

5. Who might participate?

Success in this endeavor is going to require very broad participation, international in scope. NSF's initiative in Broadening Participation is just the tip of the iceberg. We are in a highly fluid situation in which rapidly advancing economic globalization is creating a unique set of demands never before experienced by American industry or workforce. Internationalization of educational and research programs is being attempted by almost every academic institution around the world. There is no clear plan and it is not clear how to measure success in such a space. The recent NSF GENI initiative is just one of many global initiatives to come, which will require broad international participation and understanding. Our educational enterprise must meet the demands of such efforts.

References

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