

Introducing the next generation of Computer Scientists to the magic and beauty of computing

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It is ironic that one of the most significant problems facing computer scientists is that our field – sometimes known as informatics – suffers because of a lack of information among the general public about what the field involves, what kind of people are suited to a career in the topic, and the rich opportunities available for suitably trained graduates. This has led to a decline in enrolments in Computer Science in many countries, and the students that do enroll may not be the best suited for the discipline.

We are aware of a widening gap between supply and demand of qualified people; a disparity between public perception and the reality for people working in the field; and a disconnection between governments who believe that the future of their country is in ICT, yet believe that the solution to this is simply to make equipment and software available in schools.

What we need are people who have passion for our subject to communicate that to the next generation, and early enough that students have time to train with the necessary background to succeed in a fast-paced technical environment (Yardi and Bruckman 2007). Computer Science is a young discipline, and we can still meet people from the generation that recalls the excitement – the magic and beauty – of the early days of computing as digital machines opened up vast possibilities because of their flexibility. With every question that researchers answered, many new questions were raised; and programming languages made it possible to create new artifacts just from one's imagination. The early days of computer science were a period of magic and beauty – the discipline was discovering what was feasible and what wasn't; elegant structures and algorithms that used concepts like recursion to carry out complex tasks with just a few lines of code; and mysteries such as whether one small key could be found to unlock the solution to thousands of NP-complete problems.

In contrast to this, we have a generation of students who regard the Compact Disk as a dated way to store music; email as an old-fashioned way to communicate; and instant searching of billions of pages of information to be the normal way to find the answer to a question. This generation is almost inoculated against the magic and beauty experienced by earlier generations – creativity on a digital device does not involve understanding the computer, but simply using tools provided by others, whether it is YouTube, Facebook, or Garageband.

Existing approaches to outreach

Educators and employers are addressing this problem in many ways, although stagnation of interest in Computer Science seems to elude any easy solution. Some of the initiatives include:

- Programming languages aimed at children that allow them to work with visual media, including animation (e.g. *Scratch* and *Alice*).

- Robotics activities and competitions that involve the children in designing control mechanisms that must work in real time and in the real world.
- Kinesthetic and off-line activities that allow children of all ages to experience the ideas of Computer Science without having to enter over the threshold of learning to program (Bell et al. 2007).
- Material in various media, including books, videos, and magazines, which tries to convey the excitement of the field to a generation that is used to accessing information in such formats.
- Teaching the teachers – amplifying the effect of outreach programs by communicating these issues to those that in turn influence children in their life decisions. This includes parents and grandparents, as well as guidance counselors, and even the press, such as daily newspapers and television. It also includes associations for supporting teachers, such as the CSTA (Computer Science Teachers Association) and NCWIT (the US National Center for Women & Information Technology).
- Camps, after school programs and special events that use a variety of the above methods to provide an immersive experience to children, where they can form relationships over a longer period with people from the field who are passionate about it (Adams 2007, Bennett et al. 2006, Doerschuk et al. 2007).
- Competitions, such as programming competitions and software design, where students are given goals to help sharpen their skills, as well as getting to meet others with similar passions (Somers and Callan, 1999).
- Story such as the “Realm of SiPiuh” (Bianco and Tinazzi 2004), which engage young children through story that is a metaphor for the processes happening in a computer, which replaces the mysteriousness of digital devices with an understanding of the magic that they embody.
- Political action, including campaigning for more appropriate subjects to be taught in schools, and for more passionate and better trained teachers to be teaching those subjects (e.g. Yoo et al. 2006).

Because the current generation of students are so different to those even from 10 years ago, it is very difficult for educators to get into their shoes when the older generation considers ideas like search engines and portable personal digital devices to be a novelty, not a given. Taking this into consideration, the best cohort to address this issue is the small number of computer science students who have somehow come into the subject, and discovered that they have a passion for it. They might only be a few years older than the school students, but will relate much better to them. Older educators may find the passion of these younger students unusual – perhaps not “real” computer science – simply because the field has evolved under our noses and it is difficult to see how it now looks through the eyes of new students.

We still lack convincing research about what tools are the most effective for outreach, as we are still in the early stage of developing methods, and an effective longitudinal study needs to be carried out over a period of perhaps 6 years, tracing the changes of attitudes caused by outreach events from the influential age around 10 to 12 years old, through to the point at about 18 years old where a student has made a commitment to a career.

New initiatives

The problem of declining interest in computer science is sufficiently old that we know that we need to take action that is not just quantitatively different, but qualitatively different.

One initiative that is promising for producing coordinated global action is a summit called “Rebooting computing”, being organised in January 2008 by Peter Denning and colleagues who share the concern about the lack of students to create the next generation of technology (see Denning 2007). The summit will collect and foster a variety of ideas, and then provide a springboard for the most promising to be developed, deployed and evaluated. The full title of the summit was borrowed for this talk; it is “Rebooting Computing – the Magic and Beauty of Computer Science”. It is hoped that it will provide a watershed in the public perception of our discipline.

Another way we might attack the issue is combining existing methods. For example, what would the effect be if children spend time doing kinaesthetic activities from the CS Unplugged project, and then program robots to do those activities (such as finding which card has been flipped over on the ground in the parity trick, or sorting values in a sorting network marked out on the ground)? What if the characters from Bianco’s “Si Piuh” story were used as actors in the Alice programming language, and children were able to give commands to them, with their respective methods based on their roles?

It is heartening to see many researchers dedicated to the problem of how to communicate to the next generation, and perhaps sometime in the future we can look back and see the problem as a mere blip in the history of Computer Science. But in the meantime, we need to ask ourselves: “for me as an individual, what is magical and beautiful about my discipline, and how can I communicate that to the next generation?” – or even better, “What will be the magic and beauty of the next generation of Computer Science?”

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