

Towards understanding and fixing the leaking pipeline of Computer Science

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Introduction

The continued underrepresentation of women in the computer science (CS) workforce is a sobering reminder of the shortcomings of the information age. We will study the cause of this phenomenon under the “leaking pipeline” hypothesis which claims that women don’t take up CS careers because they drop out of CS courses in college. We will discuss recent research which demonstrates that there are significant differences in the way women and men learn in CS courses and that the current teaching style of these courses is more suited for men. As a result, women drop out of CS courses and the pipeline continues to hemorrhage. The papers in this survey attempt to understand and fix this problem from different angles.

In [1] the authors conducted extensive interviews of students from different ethnic backgrounds – both men and women – studying in various US colleges to understand how these students perceive their CS courses, instructors, advisors, and teaching assistants. They found that women and men differ substantially in how they perceive these “pillars of pedagogy.” In general, women had more of a negative perception than men. Based on the interview responses, the authors identified the reasons for this disparity in perception and proposed remedies.

In [2] the authors studied differences in performance of men and women in CS courses taught in Bahrain. They found that in a theoretical CS course both men and women had similar performance while for a programming course the performance difference was quite substantial. After analyzing the two courses, the authors made two conclusions. First, women don’t have any innate difficulty with “higher-order” thinking. Second, women limit their learning to what they perceive as important based on the contents of the assignments while men tend to explore further. This tendency of women puts them at a disadvantage when the assignments don’t cover all the essential aspects of the course. Consequently, they proposed a modification to the programming course which they describe as “sequential programming instruction.” They found that as a result of this modification the difference in performance between men and women was substantially narrowed.

In the following sections, we will discuss these two studies and offer our conclusions.

Perception of CS

The interviews conducted by the authors in [1] found that a majority of women (56.9 %) had a negative perception of CS classes. This was consistent across all ethnic

backgrounds except among Asian women among whom 57.1% had a positive perception. On the other hand, among men the perception was consistently positive across all ethnicities with an overall average of 59.7%. The main complaint of the students was that classes didn't appear relevant to real-world problems. Besides, the course load was very heavy and the schedule was too inflexible. The authors claim that even though many CS professors have access to a wealth of information about improving classroom instruction they are too busy to incorporate such methods in their teaching or they receive inadequate support from their department.

Further, the authors suggest that the instructors might be responsible for poor performance of female students if they treat them differently, or in any way expect them to not succeed. The study demonstrated that female students had a much lower positive perception, only 42.3% positive versus 63.2% among male students. However, the perception among female students seemed to vary widely with ethnicity; with as low as 20% positive among White students and as high as 71.4% among American Indians. The students seemed to complain about poor teaching styles, lack of communication, and a "dismissive attitude towards female students."

On the other hand, academic advisors had an overall positive perception from both male and female students. There were some differences across gender with more positive perceptions among females, 59.4%, than males, 41.7%; also, more of the female students, 91.3%, used the academic advisor than males, 80.9%. Students did complain about the expectation among the advisors that the CS program be completed in four to five years. This was a particular problem for students who needed to work to support themselves or for female students who had family obligations.

Finally, regarding teaching assistants the perception was mostly negative and consistent across both ethnicity and gender. However, female students were overall more critical of their teaching assistants, 63%, versus male students, 53.6%. The main problem with teaching assistants – roughly half of whom are of foreign origin – is their communication skills and their accent. The authors believe that a single orientation session, as is currently the norm for teaching assistants, is far from adequate.

Sequential Programming Instruction

In [2] the authors explore modifications to CS programming courses to help female students perform better. They found that women were perfectly capable of performing at similar levels to men in a theoretical CS course requiring higher-order thinking. On the other hand, in a programming course women were performing much worse than men. After carefully analyzing the differences in the courses, the authors decided that the problem was in the design of the assignments. In the theoretical course, the assignments covered all aspects of the course content that the students were expected to learn. However, the programming course's assignments only covered a few of the language features that were essential to succeeding in the course. Men tended to explore beyond these features and consequently did much better in the course. Women, however, were reluctant to explore beyond this set limited set and hence were less well prepared for the quizzes and the project.

The authors felt that assignments in a CS programming course should offer step-by-step guidance to cover all the essential features of the language rather than to let the students figure it out for themselves. They designed a modified CS programming course where detailed instructions were provided to the students on testing all the basic features of the language being taught. This gave the students a better sense of the scope of the course and much more confidence in dealing with the harder problems they had to solve later on in the course.

Finally, after reviewing the data, the authors found clear statistical evidence that the distribution of female students' scores in the new course was much closer to those of male students than in the old course. The authors concluded that courses which inherently test students' ability to plan their learning are biased against women performing well in those courses.

Conclusion

CS departments are running out of excuses for poor retention of women students. The research reviewed here has demonstrated that there is no innate lack of higher-order thinking in women. The reason for poor performance of women and consequently poor retention has to do with issues of course design and teaching style. Clearly, CS departments need to restructure their courses in light of modern pedagogy research and retrain their teachers.

Reference:

1. Gender Differences in Students' Experiences in Computing Education in the United States. Roli Varma and Heiko Hahn. *International Journal of Engineering Education*, Vol. 23, No. 2, pp. 361-367, 2007.
2. Sequential Programming Instruction and Gender Differences. Eshaa M. Alkhalifa. *IEEE Transactions on Education*, Vol. 51, No. 4, 2008.