

article:1912**Women catch up: Gender differences in learning programming concepts**

This paper describes a multi-institutional study that used categorization exercises (known as constrained card sorts) to investigate gender differences in graduating computer science students' learning and perceptions of programming concepts. Subjects were 73 undergraduate computer science students (22 women and 51 men), all within one year of graduation, from eight colleges and universities throughout the United States.

The study used a technique borrowed from the field of Expert Systems called "open" card sorts to investigate the conceptual structures students had of 26 specific programming concepts (e.g., loop, variable, object). Open sorts ask subjects to group concepts into as many categories as they like using any criterion they choose, supplying names for the categories and criterion, and repeating the process until they run out of criteria. Subjects were also asked to perform closed or constrained sorts using prescribed criteria and categories based on results from an earlier study of novices.

The paper describes our results from the constrained sorts using the criteria "Difficulty level", "When I was first introduced to it" and "When I mastered it". Using this concept-based approach to compare students by gender offered two primary advantages: First, it gave a more accurate picture of students' programming backgrounds than simply asking if they had taken a programming course or requiring them to self-rate their programming ability on a Likert-scale, common techniques from previous studies. Additionally, because it focused on concepts, rather than overt questions relating to gender (e.g., "Are women's opinions valued in this course?"), we believe it was less susceptible to *stereotype threat* - the phenomenon that can cause women's performance on a task to be altered simply because the possibility of gender bias is suggested beforehand.

Our results indicated that female subjects had significantly less pre-college programming experience than their male counterparts. However, for both males and females, we found no correlation between previous experience and success in the major, as measured by computer science grade point average at graduation. Data also indicated that, by the time students completed their introductory courses, males and females reported nearly equal levels of mastery of the programming concepts. Furthermore, females generally considered the programming concepts to be no more difficult than did males.

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Author 1: Laurie Murphy lmurphy@plu.edu

Author 2: Renée McCauley mccauley@cs.cofc.edu

Author 3: Suzanne Westbrook sw@cs.arizona.edu

Author 4: Brad Richards brichards@ups.edu

Author 5: Briana B. Morrison bmorriso@spsu.edu

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