

## Community College Women in Computer Science: Results of a Study

In the US, the rates of women's enrollment in computer science courses and completion of computer and information sciences (CIS) undergraduate and graduate degrees have declined over the last 20 years (National Science Board, 2006). Efforts to close the gender gap have been limited by a lack of longitudinal and theory-driven research on students' pathways to CIS, and a lack of research on students who enter the CIS pipeline in community colleges. Community colleges attract high numbers of females (57% according to the US Department of Education, 2008), and in 2003-4, 32% of all CIS majors at 2-year public institutions across the US were female, compared to 19% at 4-year public institutions (National Center for Education Statistics, 2007). In recent years, partnerships between 2- and 4-year institutions have focused on reducing the structural barriers to transfer, including articulation agreements (Fitzpatrick, Keyek-Franssen, et al., 2009; Morreale, Chang, & Wittenberg, 2008). But little is known about what motivates community college students to take CIS courses or the reasons they do or do not transfer as a CIS major to a 4-year university. Efforts to bridge community colleges with 4-year universities would benefit from this information.

In this presentation, we will report on the results of a study that tests three widely held beliefs about why so few women pursue CIS majors. These beliefs are supported by theory, but there is little research to support them, particularly among community college students. *One widely held belief* is that females and males have different levels of motivation to pursue these majors (Eccles, 1994; Larose et al., 2008). The *second belief* is that family support plays a critical role in choice of major, and that parents pressure or socialize their children based on gender stereotypes, a conclusion that is based on research on science and math achievement, but not specifically on CIS as an educational choice (Bleeker & Jacobs, 2004; Tiedemann, 2000). The *third belief* is that women's underrepresentation is due to a lack of previous computer use (Burger, Creamer, & Meszaros, 2007), and specifically a lack of computer game play (Cassell & Jenkins, 1998; Lynn, Raphael, Olefsky, & Bachen, 2003). However, recent data suggest women are using computers and playing games in equal numbers but in different ways (Kafai, Heeter, Denner, & Sun, 2008; Lenhart et al., 2008).

### Objectives

The objective of this presentation is to describe research findings that can be used to increase the number of community college students who pursue a 4-year degree in CIS. The findings fill a gap in our understanding of what leads community college students to take introductory programming courses, the pre-college and emerging factors that lead them to pursue a CIS major at a 4-year university, and variation within and across gender. In this study, CIS majors include those with the fewest females: database systems, operating systems, analysis of algorithms, complexity theory, computer graphics, artificial intelligence, design and construction of computer systems including computer games, and the study of programming languages. We chose to focus on students who are enrolled in an introductory programming class because these students provide a likely population to target for future CIS recruitment efforts.

### Methods

Students enrolled in Introductory Programming classes in 13 community colleges in the Fall of 2010 were invited to participate. Two initial recruitment strategies were used: in-person presentations by project staff, and email invitations by the class instructor. These were followed by in-person presentations by class instructors or a peer recruiter, and email invitations and reminders, including a link to the online survey. Participants were sent a \$25 gift card for completing the survey. The data reported here include 546 male and 191 female students that had completed most of their surveys, and that we could verify were enrolled in the designated classes. Race/ethnicity was reported as White (40%), Asian (28%), Hispanic/Latino (16%), and Multiracial (7%).

The survey included 88 items, primarily multiple choice questions drawn from prior research. Key constructs measured included academic background, previous computer use, family and mentor

support, motivation, and digital gaming experience. The dependent variable was one question: Do you plan to pursue a computer-related major at a 4-year college or university? Response choices ranged from Definitely not (1) to Definitely (5).

Data analysis included descriptive statistics and ANOVAs comparing students who intend to declare a computer-related major and those who do not by demographics (e.g., gender, age, race/ethnicity, parent occupation, and full or part-time enrollment) and predictor variables. We also conducted a series of t-tests to assess whether there were significant differences by gender on any of the predictor variables.

### Results

In this section we report the findings for the whole group, and those specific to women. As shown in Table 1, respondents' age, marital status and degrees earned were the only demographic indicators significantly related to the intention to pursue a computer-related major (CRM) at a 4 year college or university. Respondents who reported completing a degree (AA+) were *less* likely than respondents who did not complete a degree to report greater intentions to pursue a CRM. Two motivational factors (expectations for success in computing and value placed on a computing major/career are significantly related to respondents' intent to pursue a. Having a computer programming mentor was also related to intentions to pursue a CRM and the frequency of video game play, and particularly massively multiplayer online games was significantly and positively related to their intentions to pursue a CRM. Finally, spending more free time on the computer as a teen was also positively related to intentions.

Table 1  
Significant Results for Whole Sample

<u>Greater Intention to Pursue CIS</u>	<u>Significance Level</u>
Younger students	$r = -.13, p < .001$
Single and divorced/separated	$F = 5.61, p < .05$
No college degree completed	$F = 23.5, p < .01$
Expectations for success in computing	$r = .20, p < .01$
Value of computing	$r = .47, p < .01$
Computer programming mentor	$F = 7.4, p < .05$
Video game play	$r = .20, p < .01$
Massively multiplayer online games	$r = .17, p < .01$
Free time on computer as a teen	$r = .18, p < .01$

As shown in Table 2, there were several findings specific to women. Non-white females were more likely to intend to pursue a CRM than White females. Female students whose parents said to get a higher education reported being more likely to pursue a CRM than females whose parents did not say that. Females who had a mother encourage them when they first started computing were more likely to report intentions to pursue a CRM than those whose mothers did not encourage them. Female students who had a friend encourage them reported *less* intention to pursue a CRM at a 4 year institution compared to male students who did not have a friend encourage them. Finally, the more a woman played on a game console or "massively multiplayer online games" the greater intentions she had to pursue a CRM.

Table 2  
Significant Results for Women

<u>Female Group Differences</u>	<u>Significance Level</u>
Non-White females	$F = 4.18, p < .05$
Parent encouragement of college	$F = 8.38, p < 0.01$
Mother encouragement of computing	$F = 4.09, p < .05$
Friend encouragement (negative)	$F = 8.87, p = .05$
Console game play	$r = .14, p < .01$

## Discussion

The findings provide preliminary support for three widely held beliefs about why so few women pursue CIS majors at 4-year institutions. For both female and male students, high levels of motivation were associated with high intention to pursue a CIS major. Some aspects of family support were predictive for females, but not males. The finding that there were no differences in CRM intentions for students whose parents work in computing was surprising, but may be due to small sample size (only 25 females said their mother worked in computing). However, contrary to expectations, parents' gender stereotypes were not predictive. Frequency of video game play was also associated with intentions to pursue a CRM.

The results fill critical gaps in our understanding of why (and why not) students enter CIS majors. However, we need to acknowledge several limitations to the study. For example, data collection was limited to community colleges in California, so the findings may not generalize outside this population. Another limitation is that we rely on students to provide information about family support, rather than collecting data directly from parents. Although previous studies have documented the importance of actual parent encouragement and gender role expectations in predicting their child's occupational goals (Chhin, Bleeker, & Jacobs, 2008), collecting parent data is beyond the scope of this study. Instead, in this study we focus on students' internalized views of their parents' beliefs, which have been found to predict persistence in college science and technology fields (Larose et al., 2008). A final limitation is the use of univariate analyses to look at multiple predictor variables. The analyses are ongoing, and will involve multivariate analyses, such as multiple regression, which will allow us to determine the interrelationship of the predictor variables. Follow-up data will be collected in Spring 2011, and by the time of the conference in November, we will have additional information about the reasons women intend to pursue a computing-related major at a 4-year institution, including their experience in the Introductory Programming class.

### Speaker Backgrounds

Jill Denner is Associate Director of Research at Education, Training, Research (ETR) Associates, a non-profit organization in California. She does applied research, with a focus on increasing the number of women and Hispanics in computing. She has developed several after school programs and her research on these programs has contributed to an understanding of effective strategies engaging girls and Hispanics in information technology. Dr. Denner has been PI on several NSF grants, written numerous peer-reviewed articles, and co-edited two books: "Beyond Barbie and Mortal Kombat: New Perspectives on Gender and Gaming," published by MIT Press in 2008, and "Latina Girls: Voices of Adolescent Strength in the US," published by NYU Press in 2006. Dr. Denner has a PhD in Developmental Psychology from Teachers College, Columbia University, and a B.A in Psychology from the University of California, Santa Cruz.

Linda Werner is a lecturer and associate researcher at the University of California, Santa Cruz. She has a Ph.D. in Computer Science from UCSD and was the PI on an NSF-funded project on the retention of female students in CS that found greater retention when pair programming is used in introductory programming courses. She has been invited to share her research on pair programming and computer fluency at the university and middle school levels at international conferences, as well as NSF and ACM JETT/TECS sponsored workshops. Dr. Werner has extensive experience as an educator and researcher at university, community college, high school, and junior high levels. She is actively involved in working to increase the numbers of female computer science students. In addition, she has many years of experience as a software engineer in industry.