120th ASEE Annual Conference & Exposition
FRANKLY, WE DO GIVE A D*MN
June 23-26, 2013

Paper ID #5769

Alternate Pathways to Careers in Computing: Recruiting and Retaining Women Students

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His research interests include biometrics, pattern recognition, computer vision, and identity sciences. Prior to joining Clemson University, Dr. Woodard was a Director of Central Intelligence postdoctoral fellow. His postdoctoral research focused on the development of advanced iris recognition systems using high resolution sensors. His current research projects include the development of periocular-based biometric systems, ear shape based biometrics, and soft biometric classification.

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Alternate Pathways to Careers in Computing: Recruiting and Retaining Women Students

I. Introduction

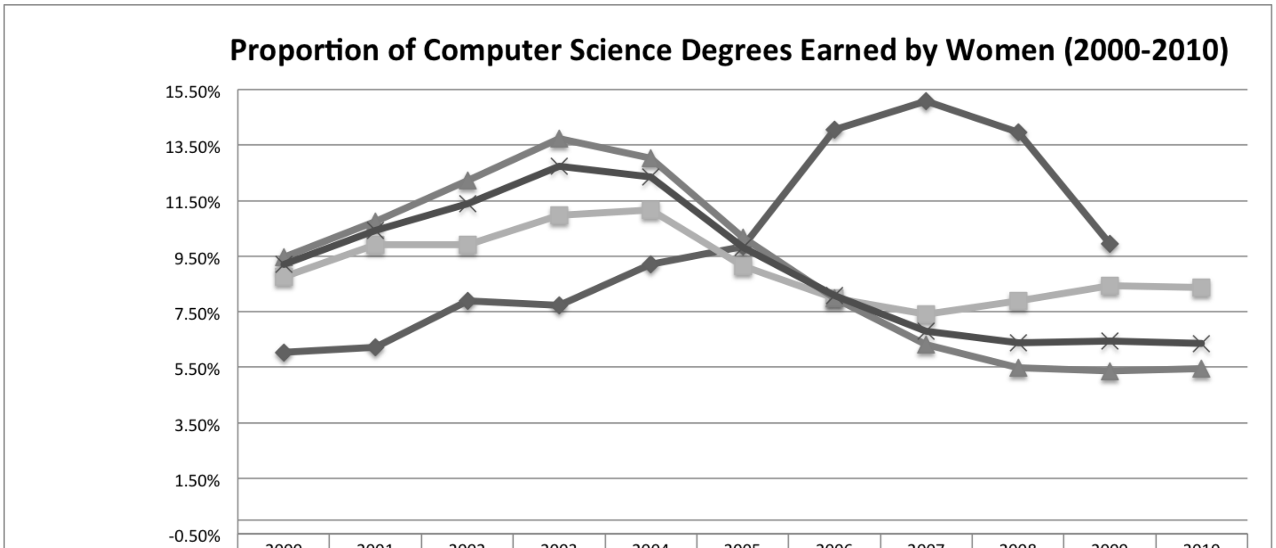
The U.S. Department of Labor (2005) has predicted an increase in demand for computer system analysts (29%), database administrators (37%), and software engineers (38%). Even with these increasing demands, there is a severe lack of representation of minority women in the field. Participation of women in computing and information technology, although never equitable, has declined during the past decade (Misa, 2010)[1]. With numerous reasons cited, including stereotypes of the field, a lack of role models, and a desire to help others, attracting and retaining women in the field is challenging; yet it is crucial to push the discipline forward. Human-Centered Computing (HCC) is a relatively new academic discipline concerned with computing and computational artifacts as they relate to the human condition. HCC attempts to solve real-world problems through the integration of computing with people, technology, information, policy and, sometimes, culture. While young, Clemson University's HCC program has the distinction of being the nation's first, and only, computing program at a major research institution that has a majority African-American and majority female enrollment. In this paper, we detail the challenges women face in computing, present three established HCC programs in the United States, and suggest evidence that HCC might address obstacles to women's participation in computing.

II. Background

Despite findings that at early ages young girls' and boys' level of interest in computing are equivalent, a common misconception is that women are simply not interested in computing (Cheryan & Plaut, 2010)[2]. Lewis (2011)[3] expresses

> *In 1987, 42% of the software developers in America were women. And 34% of the systems analysts in America were women. Women had started to flock to computer science in the mid-1960s, during the early days of computing, when men were already dominating other technical professions but had yet to dominate the world of computing. For about two decades, the percentages of women who earned Computer Science degrees rose steadily, peaking at 37% in 1984.*

Since then, computing has seen a drastic shift. Among all the STEM disciplines, computer science is one of the few that is primarily led by men in all domains, including academia and industry (Lewis, 2011)[3]. According to a recent National Center for Women in Information Technology (NCWIT), even though 25% of the current computing workforce is composed of women, Black and Hispanic women make up only 3% and 1% of this population respectively. Furthermore, the participation of women in computing fields has been sharply declining over the last decade. Figure 1 shows the proportion of computer science degrees earned by women from 2000 to 2010. Currently, far fewer women are receiving Bachelors and Masters degrees than they have in the last ten years. On the doctoral level, the number of women receiving degrees has rapidly decreased in the most recent years.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Doctorate Degrees	6.04%	6.22%	7.88%	7.74%	9.22%	9.86%	14.06%	15.07%	13.96%	9.95%	
Master's Degrees	8.77%	9.92%	9.91%	10.97%	11.16%	9.15%	7.99%	7.40%	7.90%	8.44%	8.38%
Bachelor's Degrees	9.47%	10.76%	12.21%	13.73%	13.03%	10.16%	8.00%	6.33%	5.47%	5.37%	5.46%
Total	9.20%	10.43%	11.39%	12.75%	12.36%	9.82%	8.08%	6.79%	6.38%	6.44%	6.36%

Figure 1: Proportion of women earning Bachelors, Masters, and Doctoral Degrees from four year universities from 2000 to 2010. Source: National Science Foundation WebCASPAR Database [4]

A common theory attributes this shift to the culture of computing. As the popularity of personal computers increased, so did the growth of the computing culture becoming synonymous with the stereotype of the eccentric, antisocial, male "hacker" (Martin, 2004; Moorman & Johnson, 2003; Lewis, 2011)[5,6,3] Cheryan et al. (2009)[7] coins the term *ambient belonging* to describe this phenomenon, where one assesses their sense of fit within an environment. People can be deterred from domains when they do not feel a sense of belonging or when the portrayal of the environment is at odds with how one sees him or herself, and it will prompt them to forgo attempts to join the group.

Even the socially symbolic objects, that Cheryan et al. (2009)[7] term ambient identity cues, when placed within a group environment, communicate group member stereotypes to others prospectively evaluating the group. As such, the degree to which group members are perceived as embodying the group's stereotypes, has a profound influence on the ability to effectively recruit people who do not see themselves as fitting those stereotypes. Environments can act like gatekeepers, where those individuals can feel a compromised sense of belonging in the environment, preventing them from ever joining the group. In contrast a broader view of a group, displaying a more heterogeneous array of participants encourages people to see themselves as members of the group in the future (Gardner, Gabriel, & Hochschild, 2002)[8]. Computer scientists—whether they are men or women—who embody the stereotypes of their field may be less effective at recruiting women to computer science than those who defy these stereotypes (Cheryan et al., 2009)[7]. Thus recruiting women to computing would require altering how the computing environment is perceived and increase visibility of the non-stereotypical objects and participants of computing

Beyond the perceptions of the computing field itself, the traditional research conducted in the field of computer science (e.g., algorithms, computer graphics, intelligent systems) may also serve as a deterrent to women who often prefer more people-oriented disciplines (Hell and Päβler, 2011)[9]. A study based on a data set collected over a 17-year period as part of the Michigan Study of Adolescent Life Transitions (University of Michigan, 2003)[10] found that both boys and girls who are people-oriented tend to "choose college majors in the biological sciences—medicine, environmental sciences or social sciences—rather than the mathematically based sciences such as engineering, physics, or astronomy." The two key factors their choices are based on are: "the ultimate utility of mathematics, and how much they value working with and for people." For women, these preferences are reflected in the top majors chosen by women that include business, health professions, education, history, psychology, visual and performing arts, communication, English language and literature, and liberal arts and humanities. In fact, the only major considered more of a "hard" science that is among the top ten chosen majors is biological/biomedical sciences. Even in the choice of biology-related fields; however, we see the direct opportunity for graduates to realize impacts on people as compared to traditional computer science research. Figure 2 shows the gender composition of college majors, while Figure 3 shows the chosen occupations of men and women with STEM-related degrees.

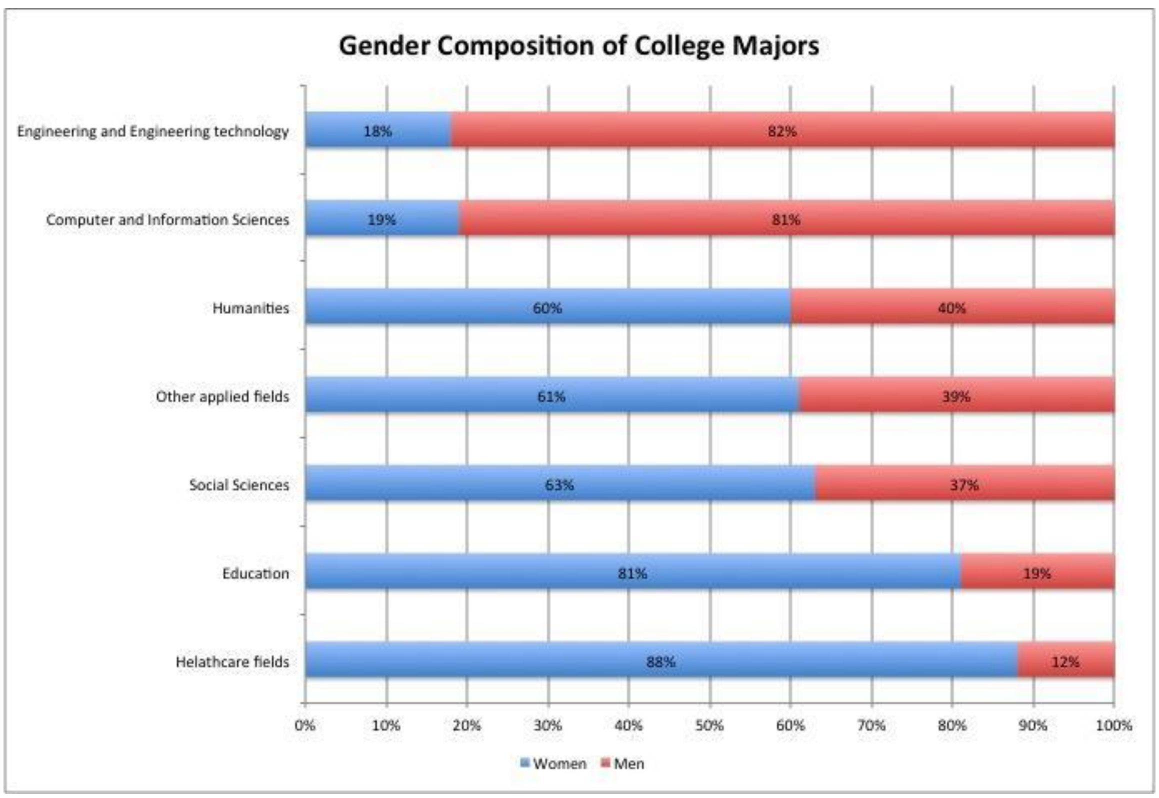


Figure 2: Undergraduate majors among 2007–08 bachelor's degree recipients and excludes graduates older than age 35 at bachelor's degree completion. Source: Authors' analysis of U.S. Department of Education, National Center for Education Statistics, 2008–09 Baccalaureate and Beyond Longitudinal Study data. [11]

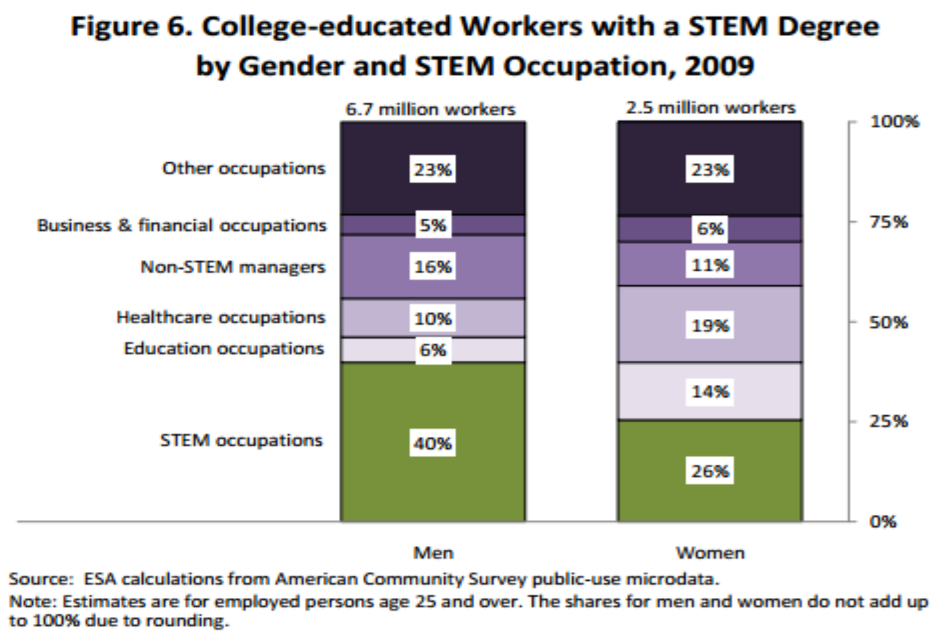


Figure 2: College-educated workers with a STEM degree by gender and STEM Occupation, 2009 [12]

The dearth of women choosing computing as a major and as a career leads to a lack of role models, as well as fewer opportunities for young women to be mentored by other women. Many studies have shown that the mere presence of female faculty role models encourages female students (Nelson, 2005)[13]. According to a forum published in *Harvard Magazine, "Forum on Faculty Diversity"* the percentage of women faculty is the single most important indicator of academic success for women undergraduates. However, without the presence of women to support and influence, the obstacles to futures in computing are daunting.

A lack of presence of female faculty diminishes opportunities for mentoring. Although we are not suggesting that female faculty can only mentor female students, there is evidence that having mentorship from other women improves the success of other females. Within higher education, mentoring has become an increasingly popular method for addressing recruitment and retention issues for women. It is often regarded as an essential component for helping women successfully matriculate in undergraduate programs in which women are underrepresented (i.e., engineering, computer science, and the natural sciences), as well as prepare for graduate training in these academic disciplines (Graham, 1997)[14]. In the research literature, it is well documented that women consistently do not receive the necessary mentoring to be successful in IT fields (Graham, 1997; Moore, Madison-Colmore, & Smith, 2003)[14,15] particularly at the undergraduate level.

Mentoring is often suggested as a way of providing women with "support, socialization, and direct assistance they need to succeed in an environment they may experience as alienating and hostile" (Jacobi, 1991, p. 518)[16]. According to the research literature, there is a strong correlation between mentoring and academic success for women (Frierson, Hargrove, & Lewis, 1994; Jacobi, 1991)[16,17] particularly at predominantly White colleges and universities. "Because the leadership and faculty of these colleges and universities are traditionally white and male, students of color and women may have less access to informal networks and other sources of support" (Jacobi, 1991, p. 518)[16]. Stated differently, these students often have difficulty adjusting and acclimating to the predominantly white male, educational environment (Graham, 1997; Jacobi, 1991; Moore et. al, 2003)[14,15,16].

In summary, we have highlighted several causes for the decline of women in computing in the past 10 years and possible solutions for this problem. We have highlighted the stereotypical perception of computing as a community of eccentric men coding in isolation that often leaves women feeling like outsiders. This perception is further exacerbated by the lack of role models and mentors to help women themselves as part of the computing community.

While many of these causes continue to be problematic, this section offered several opportunities that may be available to the field of computing to increase women's interest, enrollment, and retention in the field. On a systemic level, we have highlighted the need for better mentorship for current female students and faculty to make them want to stay in the field and become role models to future students. Research also suggests that there needs to be more strategic recruitment plans that combat the stereotypes of computing and encourage women to participate by supporting current female students and faculty who take a more active role in the recruitment process. This will provide a more heterogeneous display of participants to encourage people to see themselves as members of the future group.

Many of these approaches are being employed already to transform the image of computing and to increase recruitment of women into the field. Therefore, we have chosen to focus this paper on the growth in the field of computing toward encompassing a people-oriented perspective that will draw on the interests of women to participate in research that benefits people. In particular, we suggest that Human-Centered Computing (HCC) is an opportunity to address these stereotypical perceptions, such as a need for people-oriented research, and a lack of role models and mentors associated with the lack of women in computer science.

III. Human-Centered Computing

Human-Centered Computing (HCC) draws on the disciplines of digital media, engineering psychology, assistive technologies, architecture, industrial and systems engineering, industrial design, music, and public policy to name a few. Although there are only two other programs, at Georgia Institute of Technology and the University of (UMBC) at Baltimore County, similar to the one at our university, the field is growing rapidly. HCC can be defined as the following:

> *Human-centered computing is closely related to other interdisciplinary fields such as human-computer interaction and information science, and exactly where the boundaries between these fields lie is not clear. Broadly speaking, however, human-centered computing usually concerns itself with systems and practices of technology use. Human-computer interaction is more focused on ergonomics and the usability of computing artifacts, while information science is focused on practices surrounding the collection, manipulation, and use of information. (Wikipedia, 2012)*

HCC research meets industrial and societal needs for education and research in humanizing computer technology through understanding how computers affect human quality of life, relationships, and culture, while also designing cutting edge technologies, and exploring the underlying issues of science, engineering, art, and design. Thoroughly applied in nature, the possible impact on other people is immediately evident. Some examples of active HCC research from the three institutions include:

- Designing universal voting technologies that allow everyone to privately and independently vote on the same machine independent of their ability or disability.
- Human physiological responses, or engagement, to instruction, texting while driving, etc.
- New designs of culturally-relevant technologies for learning.
- Technologies for healthy behavior change.
- Technologies that address societal issues and policy.
- Information visualization and visual analytics highlights the ways that people make sense of data through visualizations
- Adaptive artificial intelligence characters for interactive drama and strategy games
- Information and Communication Technologies in developing countries.
- Investigation of privacy, security and networking through usable security
- Understanding how youth and adults understand computing in formal and informal settings
- Research and development of technologies for the elderly, parents, and children who are deaf or autistic to improve the quality of care and communication between family members.
- The roles of technology in informal and formal educational settings that inspire students to engage with content in new and exciting ways.
- The study of social computing on collaboration and creative project work.

The applied research focus equips students to addresses industrial and societal need embodied in Human-Centered Computing research. As a result, the programs tend to attract a wide range of backgrounds including computing, digital media, engineering psychology, architecture, engineering, industrial design, anthropology, public policy, information science and sociology – fields that have larger numbers of women.

IV. Addressing Challenges to Women in Computing

In this section, we provide an in-depth look at three HCC programs and their research foci, interdisciplinary nature, students and faculty's academic background and demographics to highlight how they attract and retain women in the field of computing.

In Clemson's HCC PhD degree program, students are required to have a strong computing or computation core with training in areas that emphasize people or the human condition and research methods for studying people, technology, policy and information. However, due to the diversity in the academic backgrounds of students applying to the HCC Ph.D. program, there are instances in which a student lacks a background in computing, or computer science (CS), and requires specialized courses to introduce non-computing students to the computing skills necessary for Human-Centered Computing research. Thus, we have designed our program to meet the needs of students with or without a computing background. We have a two-course track, HCC-600 Technical Foundations I and HCC-601 Technical Foundations II. This course sequence provides an introduction to computer topics such as the Unix operating system, high-level language programming, algorithmic foundations, and data structures. In addition, all HCC students lacking a CS background are required to take additional courses in computing, people, research methods, and a cognate/specialty area. Also, all students are required to complete HCC-831 Fundamentals of Human-Centered Computing.

A major difference between the HCC Ph.D. program and traditional CS Ph.D. programs is the requirement that HCC research topics must consist of a significant human component. To obtain training in areas that emphasize people or the human condition, students are required to complete six credits of approved courses meeting these criteria. Courses which satisfy the people component are drawn from those offered in a number of academic disciplines, including human factors, applied economics, policy studies, industrial engineering, health, and psychology to name a few. Critical to the accurate evaluation of systems involving humans is the application of sound research methods. Students are required to complete six credits of research methods and design courses. Approved courses are offered in within the computing, experimental statistics, psychology, sociology, education, and public administration disciplines. The student's research will necessitate courses specific to the research area of interest. Under the advisement of the dissertation advisor, the student will be required to complete nine credits of courses within a cognate or specialty area. Lastly, each student must complete twelve hours of CS courses from computing.

Our doctoral program is similar to the two other programs in the country. The Human-Centered Computing (HCC) PhD program at Georgia Institute of Technology has a particular focus on human-computer interaction (HCI), learning sciences and technology (LST), cognitive science, artificial intelligence (AI), robotics, software engineering and information security. Students must complete three core classes that include Introduction to Human Centered Computing, Prototyping Interactive Systems, and Issues in Human Centered Computing. They must also take 9 credit hours in an area of HCC specialization, and 9 credit hours in a minor of their choosing outside of courses offered by the college. The curriculum was designed to provide students with depth and breadth of knowledge in HCC areas. Similarly, in the HCC PhD degree program at UMBC, being a student with a strong background in computing helps, but it's not expected. The program is designed for students from a variety of disciplines; however much like our University and Georgia Tech, additional courses may be required based on a student's educational background.

With an understanding of the interdisciplinary and applied nature of the research conducted in HCC programs, as well as how all three of these programs are structured to provide non-computing majors a background in CS and allow all students rigorous training for HCC research, it appears these programs might attract and retain women in the field of computing.

At all three of the universities, there is at least 33% female faculty, with one university having a majority (57%) women faculty associated with HCC. At our university, 60% of the students are female, while 36% of the faculty is women. Thus, we can see that HCC might attract women undergraduates to computing as evidenced by the demographics of universities with HCC programs where there are already role models in place that might serve as mentors to these students.

V. Conclusions

Through this brief history of the trends in participation of women in the field of computing we've highlighted the interest of women in computing and the decline over the past ten years. We also explored the commonly attributed causes for this decline starting with the growth of negative stereotypes of computing and who participates in computing which has been attributed to the lack of feeling of belonging for women. The compounded effect this has on reshaping the culture and community of computing for future participants due to the difficulty of recruitment and retention of women in computing adversely affects the visibility of aspiring women undergraduates to see themselves as future members of this field.

We have also highlighted a possible cause of the decline or interest of women's participation in computing to types of research conducted in the field of CS. We've highlighted research on the fields that women participate in and have found that women participate in fields that are more oriented to directly helping or indirectly benefiting people even within the sciences.

Lastly, we've suggested that HCC research offers women the opportunity to participate in people oriented research, as well as computing since the field showcases computing as people-oriented. From this discussion of the three HCC programs in the country, it becomes clear that research in HCC offers alternate pathways to careers in Computing for both recruiting female students and faculty in that it offers opportunities to combine people-oriented research in the context of computing. In the case of our university, it is also evident that having additional systems in place for intentional recruitment of students and faculty, as well as mentoring, seem to play key roles in retention and successful identity development within computing.

References

1 T.J. Misa, *Gender codes: Why women are leaving computing*. Wiley, New Jersey, 2010.

2 S. Cheryan, S. & V.C. Plaut, "Explaining underrepresentation: A theory of precluded interest," Sex Roles, vol. 63, no. 7-8, pp. 475-488, Oct. 2010.

3 A. Lewis, "Girls Go Geek," http://blog.fogcreek.com/girls-go-geek-again/, 2011, (accessed Nov. 2012)

4 National Science Foundation, National Center for Science and Engineering Statistics, Survey of Research and Development at Universities and Colleges, 2008, Integrated Science and Engineering Resources Data System (WebCASPAR) (https://webcaspar.nsf.gov) [Nov 8 2012].

5 C.D. Martin, "Draw a computer scientist," in *Proceedings of 2004 ITiCSE- Working Group on Innovation and Technology in Computer Science Education*, New York, New York, Dec. 2004.

6 P. Moorman, & E. Johnson, "Still a stranger here: attitudes among secondary school students towards computer science," in *Proceedings of the 8th annual conference on Innovation and technology in computer science education*, ITiCSE '03, New York, NY, Dec. 2003.

7 S. Cheryan, V.C. Plaut, P.G. Davies & C.M. Steele, "Ambient belonging: How stereotypical cues impact gender participation in computer science," Journal of Personality and Social Psychology, vol. 97, no. 6, pp. 1045–1060, Dec. 2009.

8 W.L. Gardner, S. Gabriel, & L. Hochschild, "When you and I are 'we', you are not threatening: The role of self-expansion in social comparison," Journal of Personality and Social Psychology, vol. 82, no. 2, pp. 239–251, Feb. 2002.

9 B. Hell & K. Pa¨ßler, "Are occupational interests hormonally influenced? The 2D: 4D-interest nexus," Personality and Individual Differences, vol. 51, no. 4, pp. 376–380, Sept. 2011.

10 J. Steeh, "University Of Michigan Study Helps Define Why Fewer Women Choose Math-based Careers," http://www.ns.umich.edu/Releases/2003/May03/r052203.html, 2003, (accessed, Nov. 2012).

11 R. Tulshyan, "Top 10 College Majors for Women" from http://www.forbes.com/2010/03/02/top-10-college-majors-women-forbes-woman-leadership-education_2.html, 2010, (accessed Nov. 2012).

12 D. Beede, T. Julian, D. Langdon, G. McKittrick, B. Khan, & M. Doms, "Women in STEM: A Gender Gap to Innovation," U.S. Department of Economics and Statistics Administration, issue 04-11, Aug. 2011.

13 D.J. Nelson & D.C. Rogers, "A national analysis of diversity in science and engineering faculties at research universities," Journal of Women and Minorities in Science and Engineering, vol. 11, no. 4, pp. 389-402, 2005.

14 L.P. Graham, "Profiles of Persistence: A Qualitative Study of Undergraduate Women in Engineering," Dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA, 1997.

15 J. Moore, O. Madison-Colmore & D. Smith, "The Prove-Them-Wrong Syndrome: Voices from Unheard African-American Males in Engineering Disciplines," The Journal of Men's Studies, vol. 12, no. 1, pp. 61–73, 2003.

16 M. Jacobi, "Mentoring and Undergraduate Academic Success: A Literature Review," Review of Educational Research, vol. 61, no. 4, pp. 505–532, 1991.

17 H.T. Frierson, B.K. Hargrove, N.R. & Lewis, "Black summer research students' perceptions related to research mentors' race and gender" Journal of College Student Development, vol. 6, no. 6, pp. 475-480, 1994.