The Emerging Role of Self-Perception in Student Intentions

Jennifer Dempsey
Dept. of Computer Science
University of Arizona
jendempsey@email.arizona.edu

Richard T. Snodgrass
Dept. of Computer Science
University of Arizona
rts@email.arizona.edu

Isabel Kishi
Dept. of Computer Science
University of Arizona
ihkishi@email.arizona.edu

Allison Titcomb
Biosphere II
University of Arizona
atitcomb@email.arizona.edu

ABSTRACT

Recruitment and retention of women has been a persistent problem in the field of Computer Science. With a growing number of jobs that require a computer science degree, this problem does not only affect computer science departments with low enrollment, but also impacts industry. There is still no accepted explanation for the underrepresentation of women in the computing field. Various solutions have been implemented in attempt to resolve this problem and yet the gender imbalance in fields related to computer science persists.

In this paper we study how perceptions held by students influence their intention to pursue computer science, through a descriptive study in which we measure perceptions, attitudes, self-efficacy, and identity, then look at correlations between those and intentions to further pursue CS. Our goal is to understand how determinative these other constructs are to having students continue in the major.

We present data from a survey given out to first semester students in a computer science class and explore gender discrepancies observed from the results. Interestingly, self-perception, in terms of self-efficacy (does the student feel they are able to use computer science techniques to solve a problem) and identity does the student see themself as a computer scientist), emerged as the primary driver for differences in intention, and many aspects turned out not to exhibit statistically significant gender differences. Understanding at a detailed level what influences students to pursue computer science will be critical in devising effective interventions that can then increase participation in the computer science field.

1. INTRODUCTION

A commonly-stated concern in the field of computer science education is the decreasing enrollment rates in comparison to other science majors. Low percentages of women and other minorities entering the computing field contribute to this problem. Shortages in the workforce would be greatly reduced if more women majored in computer science [2, 6, 12]. Increasing the percentages of women would also provide a more diverse workforce in computing fields, which is critical to meet all the challenges of the information age, as technology benefits all members of society [3, 4]. For these reasons, among others, there has been a large effort to increase the enrollment of women in computer science.

To devise means of closing the gender gap, we first must understand the underlying causes. Many potential causes have been studied. Among the contributing factors, the limited availability of computer science courses before the undergraduate level is frequently cited [8]. This phenomenon leads to large knowledge gaps in introductory computer science courses at the undergraduate level, as only a select group of incoming students enters such courses with a solid background in the field. This knowledge gap is also claimed to differ between genders [8]. Ultimately, it can discourage women from entering a computing-based field.

Many of the identified causes of the current gender gap in computer science pertain to students' perceptions. Past research has shown that incorrect or incomplete perceptions may deter women from entering the field. Specifically, stereotypes of computer scientists, self-efficacy in computer science, and the belief that computer science can only lead to a career in programming are among the studied types of perceptions.

Numerous new programs, recruitment techniques, and workshops have been implemented in hopes of addressing the potential causes of the gender gap in computer science. However, even today, few women chose to pursue a degree or career in computer science.

In this paper, we consider the extent that various perceptions may contribute to the small percentages of women in the field. Rather than starting from a proposed intervention, we instead analyze the perceptions of students concerning computer science. Through administering a survey to introductory students we can identify more precisely the discrepancies in perceptions of computer science between genders.

2. RELATED WORK

Previous work that identifies perceptions as a cause to the gender gap typically focuses on a few different types of perception. Perceptions related to computer science include students' beliefs as to what computer science is, who

SIGCSE '15 Kansas City, USA

computer scientists are, and if they have the abilities that computer scientists possess.

Many students do not comprehend the breadth of the computer science field. Unlike other scientific fields, students are not typically exposed to computer science until they reach the undergraduate level. Hence, a student may enter an introduction to programming class as an undergraduate with incorrect or incomplete notions about computer science, computer scientists, or their own abilities to succeed in computing. Often, incoming student's believe that computer science is mainly focused on programming and that the skills taught in these classes cannot be used to solve real world problems. For example, a study by Carter [7] examined why students who would statistically flourish in the computer science field, instead continued in another. This study determined that one main contributing factor is that these students do not have a complete understanding of what topics are covered in a computer science degree. In addition, a study undertaken at Georgia Institute of Technology showed that a belief that computer science does not have many real-world applications is among one of the top reasons women end up leaving the computer science field, whereas this idea does not seem to affect men's choice of major [5].

Another deterrent to students entering the field of computer science is that they often associate the field with certain stereotypes [1]. Often individuals with an interest in computing are described as being male, and of either Caucasian or Asian descent. In fact, several of the individuals interviewed for the "Stuck in the Shallow End" book gave reasons for not attempting AP Computer Science that included the notion that it was a class for white and Asian males [11]. Also students with limited knowledge of the computer science field negatively described it as a very solitary, repetitive activity, discouraging them from enrolling in a class [7]. This narrow image of the computer science field and of the individuals involved is often portrayed in the media, making it increasingly difficult to recruit individuals that lie outside this stereotype into the field.

It has also been shown that a student's intentions to pursue computer science is correlated with self-efficacy in computer science [13]. Miura demonstrated that men rank themselves higher in self-efficacy in comparison to women. Additionally, this survey found that there was a positive relationship between an intention to take a computer science class and self-efficacy in computer science [13]. In this study we expand the idea of intentions in computer science to consider a wider variety of granularities. This includes if a student intends to learn more about computer science on their own, as well as, if a student plans to pursue a career in computer science.

Finally, it has been shown that females are less likely to be confident that they have the skills needed to pursue computer science [8]. It has been observed that girls at a young age are more motivated to work with computers than their male counterparts. However, as the individuals age, the confidence gap between men and women reverses and then grows, even if students have access to computers and computer science classes.

3. UNDERSTANDING PERCEPTIONS

In addressing the problem of low enrollment in Computer Science through effective interventions, it is important that we understand the underlying causes for this low enrollment. We focus on students, primarily freshmen, at the University of Arizona taking the introductory computer science course. We present a descriptive study in which we measure various aspects of each student's perceptions, then examine correlations between those and intention to further pursue CS. Our goal is to understand how determinative these other constructs are to having students continue in the major.

We devised six psychological constructs that we feel may play a role in a seventh construct: a student's intention to continue in computer science. Those six contributing constructs are (a) perceptions of computer science, (b) attitudes about science in general, (c) attitudes about computer science specifically, (d) science self-efficacy, (e) computer science self-efficacy, and (f) computer science identity. We measured these constructs at the very beginning of the course, to ensure that the students' experience in that course was not a factor. (Ideally, we would naturally hope that the course addressed the gender differences we describe below, but that is a completely different question.)

3.1 Construction of the Survey

The survey consists of 36 items, each a statements that we asked each student to rank on a seven-point scale Strongly Disagree, Disagree, Somewhat Disagree, Neither Agree nor Disagree, Somewhat Agree, Agree, Strongly Agree. This scale allows us to decipher smaller amounts of change between groups that with a smaller scale system.

Items where presented in one of three orders to students, with about a dozen items per page.

We also collected some basic demographic information. This included the student's major, prior classes that the student took, and, most relevant to this analysis, gender.

The entire survey was presented to each student in an electronic form that could be completed at a location and time of the student's choosing.

We now outline the survey items were constructed to measure specific perceptions in computer science.

3.2 Intention to Continue in Computer Science

The objective is to is gauge a student's intention to continue on in the Computer Science field. We consider this at the following granularities: enroll in another course, major in CS, pursue a CS career, and plan to learn more about CS on their own (four items). Our starting position is that such CS intentions may be affected by perceptions, that is, by what a subject understands or feels.

We studied the following perceptions, each of which may influence a student's decision to continue on in the field of CS.

- Perception of computer science (methodologies it includes),
- Attitude towards science in general (feelings about science),
- Attitude towards computer science,
- Self-efficacy in doing science (do they have skill in doing science),
- Self-efficacy in doing computer science, and

- Self-concept of the individual (do they see themselves as a computer scientist).

We now examine each in turn, briefly summarizing the statements that we chose to represent each perception. We attempted to be thorough while restricting ourselves to a reasonable number of items.

3.3 Perception of Computer Science

Often perceptions of the computer science field are limited to just programming; however, the field of computer science contains many more aspects beyond this narrow view. We attempted to investigate if student's believe computer science is solely based on programming and to what extent their perceptions a limited to only certain areas of the field. A series of statements was used with each statement describing a particular aspect computer science.

The statements for this portion of our survey were developed from an AWE (Assessing Women and Men in Engineering) assessment. AWE provides these assessment tools for use in educational settings[1]. We changed the statements about scientists (e.g., work on things that help the world, analyze experimental data, gather and analyze data to answer questions) and applied them to computer scientists (7 items in all).

The student was asked how much they agree or disagree that scientists partake in these aspects. For example, one statement that was "Computer scientists analyze experimental data". Stereotypes of computer scientist do not support this statement because it implies that computer science is more than just programming, but many computer scientists do gather or analyze data similar to other related fields.

3.4 Attitudes About Science and CS

Attitudes (i.e., how the student feels about science or about computer science, such as do they like it, do they think it's important) may also play into whether a student wants to pursue CS. Formally, Attitudes are defined as "evaluations of objects, of events, or of ideas" [9]. We consider attitude in both terms of attitudes towards science and more specifically in terms of attitudes towards computer science. We measured science attitude with a set of statements to asses whether a student's attitude towards science is generally positive or negative. Positive attitudes in this area include the importance of science, if the student enjoys science, and if a student enjoys taking science-based classes. We considered attitudes towards computer science in a similar manner: we simply substituted the term "computer science" for any instance of "science" in each statement. From previous research we expect that attitudes towards computer science differ between men and women. With such statements we can discern if a student has a negative or positive attitude toward science and toward computer science. There were three items pertaining to science and six pertaining to computer science.

3.5 Self-Efficacy, in Science and CS

Self-efficacy is "a person's belief that he of she is capable of the specific behavior required to produce a desired outcome in a given situation" [10]. As before, we measured both science self-efficacy (e.g., does the student feel he or she is able to use the scientific method) and the more restricted CS self-efficacy (e.g., does the student feel he or she is able to use computer science terms to share my results).

The statements that we used to measure self-efficacy in science focus on the students beliefs that they can effectively communicate a scientific procedure to others, can use models to explain my results, and could become scientists. To generate statements that measure self-efficacy in computer science, similar statements were used except any reference to science was replaced with computer science and the phrasing was adjusted to encourage the student to read each statement carefully. These statements are designed to measure self-efficacy for a student in general science classes and computer science classes outside of the typical misconception that computer science is only programming.

The statements used to measure both computer science and science self-efficacy were based off of a Science Process Skills Inventory[2] that was intended to measure skills needed to process information, rather than content knowledge of science. Mary Arnold, one of the authors of that inventory, gave us permission to adapt the statements and response scale to fit our needs. We chose a subset of the statements in the initial inventory, to maintain a reasonable total length; for self-efficacy pertaining to computer science we replaced "science" with "computer science". Hard to understand" Note that some of the statements that we chose to omit were based on if the above alteration to make a statement about computer science would produce useful data. For example, one of the original statements reads "I can use data to create a graph for presentation to others." This statement proved difficult to transform such that it pertained specifically to computer science so we chose to omit it.here were six questions pertaining to self-efficacy in science and seven concerning self-efficacy in computer science.

3.6 Self-Concept

Finally, we consider CS identity, specifically self-concept: does a student see themselves as a computer scientist. Self-concept is defined to be "the sum total of an individual's beliefs about his or her own personal attributes" [10]. To measure a student's self-concept as a computer scientist, we used three items. The statements were designed to measure the importance of computer science as part of who they are: 'majoring in computer science is important to me'. Beyond this statement, other statments consider different granularities of this concept, such as, being a computer scientists, and being able to use computer science to solve problems.

The initial questions, "Do you think you could become a scientist?" and "Do you think you could become a computer scientist?" were originally from [14]. These original questions also asked students to explain their answers. Rather than requiring this explanation we applied the seven-point scale to the items. The explanations may prove useful in future studies, but for our purposes we just wanted to be able to gauge if a student could identify with being a computer scientist or scientist.

[1]This assessment was developed by researchers at the Pennsylvania State University and University of Missouri, `http://www.engr.psu.edu/awe/misc/about.aspx`, retrieved September 5, 2014.

[2]My Science Skills (©2010 Oregon State University, Bourdeau, V.D. & Arnold, M.E. (2010) *The Science Process Skills Inventory. Corvalils, OR: 4-H Youth Development Education, Oregon State University.*

4. SUBJECT POOL

As outlined above, Our approach is a descriptive study, in that we measure perceptions, attitudes, self-efficacy, and identity, then look at correlations between those and intentions to further pursue CS, to understand how determinative these other constructs are to having students continue in the major.

We gave this survey electronically to students in CSc 127A for the Fall 2013 and Spring 2014 semesters. A total of 219 students agreed for their answers to be included in this study, though not all answered every question. Approximately one-quarter of the students were female. Note, this class is an introductory class in the computer science major, but it also required for several related fields including, but not limited to, mathematics and engineering.

5. ANALYSIS OF SURVEY RESULTS

The goal of this investigation is to gauge (i) whether our specific measures of each of these constructs sufficiently hold together (in a statistical sense) to indicate that the construct itself is captured, (b) whether there is a significant difference between genders, and (c) to what extent do the other constructs correlate with CS intentions.

5.1 Construct Reliability

As discussed above, for each construct we used several items, with the goal that these items "hang together" well, measuring the same concept. A conventional indication of this is Cronbach's Alpha (α), where a value of 0.7–0.8 is considered good.

We consider a construct's answers to "hang together" if a student's answers in a single category all fall in the same general area of the sevent-point scale, with the exception of questions that are reverse coded, which should have answers on the opposite end of this scale.

Most of the constructs held together quite well: perceptions of CS ($\alpha = 0.837$), science attitudes ($\alpha = 0.779$), CS attitudes ($\alpha = 0.822$), science self-efficacy ($\alpha = 0.855$), CS self-efficacy ($\alpha = 0.837$), and CS identity ($\alpha = 0.814$).

The one construct that did not hold together was CS intentions, with $\alpha = 0.664$. This implies that the individual items are not all testing the same concept, but that there are multiple, perhaps overlapping concepts being tested, We will return to this construct shortly.

5.2 Gender Differences

We were surprised that for most of the constructs, there were no statistically significant differences between men and women. In particular, there were no gender differences concerning (a) perceptions of CS, (b) attitudes of science, (c) attitudes of computer science, or (d) science self-efficacy.

These results have broad implications. As discussed above in Section 2, some of the past research has been predicated on informal beliefs that women perceive CS differently, or that women do not feel that they are good in science, or that women feel as though they will not be able to work with others in the computer science field if they fit their believed stereotypes of computer scientists. Our results imply that for those we surveyed, those are in fact not significant gender-specific attitudes or perceptions.

There were statistically significant (< 0.01) gender differences in just three constructs: CS self-efficacy ($M_f = 4.44$; $M_m = 5,09$) and CS identity ($M_f = 4.44; M_m = 5.05$), as well as intention ($M_F = 5.00; M_M = 5.44$). This leads to the initial conclusion that even though CS has "science" in its name and is considered a STEM discipline, CS seems to be different than other sciences. It seems that the difference can be attributed broadly to (a) whether the student perceives that he or she can excel in computer science (self-efficacy) and (b) whether the student see themselves as a computer scientist (identity). Women to a lesser extent see themselves are being able to *do* computer science and as *being* computer scientists. Note that there was no difference between men and women on *science* self-efficacy.

Concerning CS intentions, there were significant gender differences on two of the items: "I would like to take another computer science class" ($M_f = 5.16; M_m = 5.63$) and "I plan to major in computer science" ($M_f = 3.82; M_m = 4.68$). For the other two questions ("I would consider a career in computer science" and "I would like to know more about computer science") there were no statistically significant differences. It seems that the distinction in these questions is that women are different than men on *inwardly* oriented questions but not on the *outwardly* questions.

This also relates to the fact that this construct does not hold together. Interestingly, Cronbach's alpha gets higher ($\alpha = .701$) for men if the item "I wouldn't consider a career in computer science" is removed, meaning the other three hang together more than that one. For women, Cronbach's alpha improves ($\alpha = .731$), if the statement "I would like to know more about computer science," is removed, meaning the other three go together better.

We conclude from this study that it is *not* what women think about computer science, but rather how they think about *themselves* within this discipline. Specifically, it is not that women don't like CS or are not interested. (In fact, they feel that they can do well in CS.) The critical challenge is with *identity* and only with CS, not with science in general, which is perhaps why other sciences are not experiencing problems with participation of women.

5.3 Correlations with Intention

A separate question is, which constructs correlate with CS intentions? We should generally be concerned only with those that do so correlate.

We found that neither science attitudes nor science self-efficacy correlate with CS intentions. This result emphasizes that students do not see computer science as a science.

CS intentions do correlate at statistically significant levels with CS perceptions (0.243), CS self-efficacy (0.256), CS attitudes (0.407), and CS identity (0.646). Unfortunately, the strongest correlate, CS identity, is the one exhibiting the most gender imbalance. CS self-efficacy seems to also be a factor, but a lesser one.

(We emphasize that correlation is not causality. We hypothesize that it is the gender differences in CS identity and self-efficacy that are causing the differences observed in CS intensions, but cannot rule out that the causality doesn't go the other way.)

5.4 Potential Interventions

The data from this survey implies that interventions should not focus primarily on perceptions or attitudes of CS. Rather, the problem appears to lie primarily in self-perception and only with reference to CS, not with reference generally to science,

Table 1: Survey results for men in computer science; 1 is strongly disagree and 7 is strongly agree.

Construct	Number of Participants	Mean	Standard Deviation
Intentions in CS	158	**5.4351**	1.01234
Perceptions of CS	150	5.5124	.81960
Attitudes towards CS	153	5.8420	.69716
Attitudes towards Science	148	5.7523	.91359
Self-efficacy in CS	148	**5.2181**	.86399
Self-efficacy in Science	146	5.5297	.80817
Self-Concept as Computer Scientist	149	**5.0582**	1.18849

Table 2: Survey results for women in computer science; 1 is strongly disagree and 7 is strongly agree.

Construct	Number of Participants	Mean	Standard Deviation
Intentions in CS	61	**4.9918**	1.09541
Perceptions of CS	55	5.6909	.62437
Attitudes towards CS	57	5.7105	.81742
Attitudes towards Science	57	5.5205	1.20023
Self-efficacy in CS	55	**4.6104**	1.19094
Self-efficacy in Science	55	5.3455	.89515
Self-Concept as Computer Scientist	58	**4.4425**	1.20023

Interventions that change self-perception vis-a-vis CS, specifically identity, may be effective. However, the simple fact that there are few women in CS is a daunting situation.

Another potential approach would be to do a better job to frame CS as a science, like other sciences. As noted above, there are not significant gender differences in attitudes or self-efficacy concerning science.

5.5 Summary of Analysis

The final results from the survey are listed in Tables 1 and 2 for men and women respectively. For most of the constructs listed in these tables there are no statistically significant differences between genders. However, significant gender differences (shown in **bold**) can be observed for both self-efficacy in computer science and self-concept as a computer scientist. Additionally, significant differences between men and women were observed concerning intentions to pursue computer science. Specifically, women agree less with these statements if we only consider the inwardly-oriented questions. Lastly, the strongest correlation occurs between intentions to pursue computer science and identity as a computer scientist. Identity also happens to be the construct that has the greatest discrepancy between men and women.

6. CONCLUSIONS

Females report having lower computer science self-efficacy and computer science identity. Importantly, both of these variables significantly correlate with intention to continue on in computer science. These results suggest that computer science self-efficacy and computer science identity might play a role in the underrepresentation of women in computer science careers. Important to note, females and males did not differ in science self-efficacy, indicating that this is specific to computer science. In addition, another interesting finding is that women and men did not significantly differ in attitudes of either CS nor science nor perceptions of CS.

From these findings we can conclude that solutions to close the gender gap in computer science might be more effective if they focus on changing women's perceptions of themselves in the computer science field. This is contrary to many of the current methods for encouraging women to pursue computer science. These methods often focus on generating interest in the computer science field, or on making computer science more appealing to women.

7. FUTURE WORK

Our study leaves two distinct areas for future work in terms of determining the role of perceptions on students' intentions to pursue computer science. First altering the subject pool for this survey, or distributing the survey to the same subject pool multiple time,s may provide us with more generalizable information. Secondly, we plan to polish the constructs that were created for this survey in hopes that each construct will hang together well, and will fully capture the most important aspects of the construct.

7.1 Changes to the Subject Pool

The finding described about leave several opportunities for future work. Among these is to determine if student's perceptions alter after completing an introductory course in computer science. Many introductory courses focus on teaching basic programming constructs and could even support common misconceptions about the computer science field. In the introductory course at the University of Arizona, we will be attempting to expose students to a different method of framing computer science lessons that is similar to other science classes, in addition to the material that emphasizes programming. This approach might allow students to perceive computer science as being more closely related to other science courses. The survey data presented in this paper suggests that being able to convince women that computer science is a science could positively influence their intentions to pursue computer science. Ultimately, we could observe this change through a survey given at different times throughout the offering of the introductory course.

Additionally, this survey could be applied to students taking a more general computer science course that is not part of the major. This would open up our survey to individuals that had not initially intended to pursue a computer science degree. In the Spring of 2015 the University of Arizona is offering a computer science course as a general elective that will focus more on the theories behind computer science, rather than basic programming concepts. Students in this type of class will typically be students that are interested in learning more about computer science who do not necessarily intend to pursue a degree or career in the field.

Another area of future research could involve tracking how a student's perceptions change as they continue on while pursuing an undergraduate degree in computer science. Administering our survey multiple times throughout the career of undergraduate students could give us an opportunity to observe how changes in perceptions can factor in to the retention rates in computer science departments.

Lastly, we will be making our survey available with the hope of collecting data from other universities in a wider variety of fields and potentially students at the high school level, and we may also revise the current survey to make it accessible to middle school students.

7.2 Changes to the Survey

We plan to refine our survey based on the results reported here to better capture differences in perceptions between genders. To begin with, we plan to separate intentions in computer science into two separate constructs, One considering intention to pursue a career or other long term goals in the field, and the other construct to gauge intention to pursue computer science as an interest or as a tool to support a career in a related field. We believe that this produce two conctructs that hang together better that our original construct for computer science intentions.

Additionally, we did not observe any effects of the common perception that computer science mainly involves coding. To better determine if the perception of computer science as programming impacts intentions toward computer science, we plan on creating another construct for perception of the computer science field that focuses on computer programming. We feel that this is important to study due to the sheer amount of prior research that speculates that this perception is a part of the reason why enrollment in computer science courses is low. This new construct for computer science as computer programming, would measure students' believes about the amount of coding ablity and creativity needed to be a computer scientist. This construct may also bear light on why some women do not see themselves as computer scientist, while having high self-efficacy in science.

7.3 Potential Interventions

Our data from this survey implies that interventions should perhaps not focus primarily on perceptions or attitudes of CS. Rather, the problem appears to lie in self-perception and only with reference to CS, not with reference generally to science,

Interventions that change self-perception vis-a-vis CS, specifically identity, may be effective. However, simply the fact that there are few women in CS is a daunting situation.

Another potential approach would be to do a better job to frame CS as a science, like other sciences. As noted above, there are not significant gender differences in attitudes or self-efficacy concerning science.

Acknowledgments

We would like to thank Jaimie Sols who constructed the original version of our survey and Melanie Brucks for her contributions in developing the constructs and questions used in the final version of the survey and her help with the statistical analysis. Partial support was provided by NSF grants CNS-0938948 and IIS-1016205.

8. REFERENCES

[1] M. Adya and K. Kaiser. Early determinants of women in the IT workforce: a model of girls' career choices. *Information Technology & People*, 18(3):230–259, 2005.

[2] D. E. Agosto, S. Gasson, and M. Atwood. Changing Mental Models of the IT Professions : A Theoretical Framework. *Journal of Information Technology Education*, 7:20, 2008.

[3] A. M. Balcita, D. L. Carver, and M. L. Soffa. Shortchanging the future of information technology: the untapped resource. *ACM SIGCSE Bulletin*, 34(2):32–35, 2002.

[4] S. Beyer, K. Rynes, and S. Haller. Deterrents to Women taking computer science courses. *Technology and Society Magazine, IEEE*, 23(1):21–28, 2004.

[5] M. Biggers, A. Brauer, and T. Yilmaz. Student perceptions of computer science: a retention study comparing graduating seniors with CS leavers. *ACM SIGCSE Bulletin*, 40(1):402–406, 2008.

[6] T. Camp. The incredible shrinking pipeline. *Communications of the ACM*, 34(2):129, June 1997.

[7] L. Carter. Why students with an apparent aptitude for computer science don't choose to major in computer science. *Proceedings of the 37th SIGCSE technical symposium on Computer science education - SIGCSE '06*, 38(1):27, 2006.

[8] J. Cohoon, McGrath, and W. Aspray. *Women and Information Technology: Research on Underrepresentation*, volume 1. The MIT Press, 2006.

[9] M. Gazzaniga, T. Heatherton, and D. Halpern. *Psychological Science*. W. W. Norton & Company, New York, 3 edition, 2010.

[10] S. Kassin, S. Fein, and H. Markus. *Social Psychology*. Wadsworth Cengage Learning, Mason, OH, 8 edition, 2008.

[11] J. Margolis. *Stuck in the shallow end: Education, race, and computing*. MIT Press, 2008.

[12] C. McCullough. Attracting under-represented groups to engineering and computer science. *Population*, pages 1–11, 2002.

[13] I. T. Miura. The relationship of computer self-efficacy expectations to computer interest and course enrollment in college. *Sex Roles*, 16(5):303, Mar 01 1987. Last updated - 2013-02-24.

[14] S. H. Wingenbach, G. J. Degenhart, K. E. Lindner, J. R. Dooley, D. L. Mowen, and L. Johnson. Middle school students' attitudes toward pursuing careers in science, technology, engineering, and math. *NACTA Journal*, 2007.