Dispelling Computer Science Gender Myths:
Perceived Confidence Levels Between Undergraduate Men and Women

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Abstract

This study is part of an ongoing line of investigation into the culture of computing among Computer Science undergraduates at Carnegie Mellon University. This study, focusing specifically on confidence, is looking especially at gender similarities (which have often been ignored in favor of examining gender differences), in an attempt to dispel some common stereotypes that surround women and men in computing fields. Our findings relating to confidence levels support the recent findings of Blum and Frieze, who found many similarities in how undergraduate men and women relate to computer science here at Carnegie Mellon University. Based on new insight gained from our investigation of student interviews and surveys, suggestions are made to enhance the learning experience for undergraduate women in the computer science major. Ultimately we hope our suggestions may benefit all students.

Dispelling Computer Science Gender Myths: Perceived Confidence Levels Between Undergraduate Men and Women

Background

Computers now have great influence on our lives. We have come to rely on them to get much of our work done and as part of our entertainment options. With females representing more than half of the US population, it seems essential that women's ideas should be a part of the design of computer systems.

However, even fewer women than before are considering majoring in computer science (CS). With fewer women majoring in computer science, fewer women have the right skills to enter the workforce. According to the National Science Foundation, half of the bachelor's degrees in science and engineering fields are awarded to females. In general, the numbers of degree awards in science and engineering fields have increased since 1966. However, in computer science, the reverse is true. The number of bachelor's degrees in CS awarded to females dropped from 37 percent in 1985 to 28 percent in 2001. This situation can only get worse as the pipeline to freshmen CS continues to decline. According to the Taulbee Survey, which examines only the top tier CS universities (CS departments ranked 1-36), the number of undergraduates declaring computer science as their major declined by 39 percent since Fall 2000. In each of the past two years, there has been a seven percent decrease in enrollment in the computer science programs. From 1998 to 2004, women enrolling in computer science has fallen 80 percent. These statistics point to the importance of encouraging and retaining women in the computing fields.

Confidence - General

Self-confidence plays a valuable role for students deciding whether or not they want to continue in the computer science major or any other major. Prior research (Fuller et al) has shown that the lack of confidence in a certain subject matter is often a precursor to losing interest in that subject. When students lose interest, they often wish to transfer out of their current major. Examining confidence levels may lead to a better understanding of why students leave the major and what efforts may be implemented to retain students.

Confidence also affects their success their chosen field. Students who feel more confident about a task are more likely to set higher goals for themselves (Babcock). They are also more likely to persist in achieving that goal. Students with lower goals may settle for less, and therefore not reach their full potential.

Research suggests that women tend to have lower confidence levels than men. Different socialization messages in our culture have been shown to be partially responsible for the confidence gap between men and women. Research has shown that "boys are expected to develop self-confidence… whereas displaying self-confidence has traditionally been a gender-role violation for girls" (Kling, Shelby-Hyde, Showers, & Buswell, page 472).

Confidence - Computer Science

With regards to computing, the finding that women have lower confidence levels has also been confirmed (Margolis & Fisher, Scragg & Smith, Spender). Spender suggests that the confidence gap may result from men receiving more hands on experience with computers. Many male centered materials, such as computer games, create a culture where men are encouraged to interact with computers outside the classroom. This increased

interaction may help to increase confidence. Women, who are not targeted, are more likely only to interact with computers to do the work required of them.

Fuller et al studied the confidence levels of incoming engineering students at North Carolina State University. They found that on average, women entered college less confident than the men in their class. Even though women's academic performance was equal to their male cohorts, their confidence decreased more than the men. They also found that confidence for both men and women decreased initially. However they note that women were more likely to express a desire to switch majors. This suggests that low confidence is a precursor to transferring.

Prior research on undergraduate computer science students found that the decrease in confidence was affected by the social environment and the biased assumption that females are not as likely as males to be computer scientists (Margolis & Fisher, Teague). These biases influenced professor's treatment of their students which in turn influenced student confidence (Gurer & Camp). Professors, both male and female, have a tendency to call on the male students more often. In addition, they have a tendency to ask the male students more difficult questions. Learning styles for women conflicted with the instructional styles of the professors (Felder). All of these factors have been found to contribute to low confidence levels in women.

Beliefs (both conscious and unconscious) that females are not as likely as males to be computer scientists can strain peer interactions, and cause women to question their abilities, creating a non-conducive learning environment. One study shows that "the students peer group is the single most potent source of influence on growth and development during the undergraduate years" (Astin). Male students may belittle women when they ask questions on topics they believe are basic computer science concepts (Gurer & Camp). When working in a cooperative learning environment, women's contributions were often discounted (Felder). This may have also led women to be less active in group settings.

Similarities Emerge

Previous gender studies have focused on gender differences. In the midst of the search for differences, it is often easy to overlook similarities between the genders. However, we must wonder: Are men and women really *that* different from each other?

Although women may have the ability and the aptitude for computing, many do not choose to pursue computing related careers. Often times, women are deterred by the supposed need for mathematics (Durndell & Lightbody, Teague). The belief that women are inferior to men in mathematical abilities has existed for a long time. Contrary to common belief, men are not naturally better at math than women. Barnett and Rivers note that the difference between men and women's math ability is slight. They note that there is a huge overlap. Rather, men and women are far more alike than different in their mathematical skills.

Barnett and Rivers also argue that the magnitude of gender difference in self-esteem is small and unlikely to have important consequences. Rather than accepting that women have lower confidence, they note that women tend to be more ambitious than men, holding themselves to higher standards of performance. With higher standards, women may have lower confidence when they fail to meet their lofty standards. This may explain the lower confidence ratings that women give themselves.

These similarities seen helped to form the basis for this study. We wish to understand if there are similarities amongst computer science undergraduates that may have been overlooked.

Carnegie Mellon University

Alan Fisher and Jane Margolis conducted a longitudinal study regarding women in computer science at Carnegie Mellon University over a period of four years (1994-1999) that examined the computing experience at Carnegie Mellon University for men and women. Margolis and Fisher found that confidence levels for women decreased over the course of the four years in college. In fact, they suggested that confidence levels in women were "extinguished" (Margolis & Fisher, page 77).

At Carnegie Mellon University, only 7% of the incoming computer science freshmen were women in 1995. Since 1999, women have constituted about a third of the incoming computer science class each year. Factors that contributed to this increase include modifications to the admissions and outreach to teachers, all the while keeping the same high academic standards for both men and women applicants.

Margolis and Fisher also showed that previous experience in computing did not necessarily indicate future success in the field. Carnegie Mellon University used this information along with Dean Raj Reddy's vision of producing leaders in the field of computer science, and shifted its CS admissions policy away from looking for students with prior programming experience towards accepting students with leadership potential (Margolis & Fisher, Blum & Frieze). It should be noted that the revised admissions policy kept the high academic requirement for all students. This policy contributed to a broader range of students, both men and women, and an increase in the number of women in the incoming classes.

As a brief follow-up to the Margolis/Fisher studies, Blum and Frieze conducted a study based on interviews with computer science seniors from the class of 2002. Their findings led them to suggest that the culture of computing at Carnegie Mellon had transformed as the student body became more balanced in terms of gender, the mix of students, the breadth of interests, and the professional experiences afforded all students (primarily though the development of Women@SCS, an organization that formalizes professional, academic and social opportunities for women) (Blum & Frieze).

Frieze conducted another interview project with computer science seniors in the spring of 2004. The transcripts from these interviews serve as the starting point and major source of data for this research study into gender similarities and differences in confidence levels among students in this new "balanced" environment. Blum and Frieze found that gender differences tended to dissipate in a more balanced environment. Prior research studying gender and computer science examined students in gender imbalanced environments and noted a strong gender divide.

This particular study on perceived confidence levels, is part of an extended study with Carol Frieze and Catherine Fan[1], and aims to examine gender similarities and differences. The study will focus on similarities, which may have been overlooked as much of the prior research focuses on differences. We hypothesize that in this balanced environment, we will find similar results to Blum and Frieze, 2004, that is, in a more balanced environment, gender differences tend to dissolve.

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[1] This work was conducted with Catherine Fan and Carol Frieze as part of a larger study: "Motivation, Persistence and Success in Computer Science: What Can Computer Science Seniors Tell Us?"

Research Methodology

Interviews

Frieze collected over 50 transcripts from interviews with the class of 2004 seniors. Questions were modified from the questionnaire used by Blum and Frieze in 2002 which was based on the Margolis/Fisher questionnaire. (Refer to Appendix A for the list of questions.) We randomly selected a pool of 22 men and 22 women to provide an equal distribution of men and women. From the women, five of those included are members of Women@SCS such that the proportions of women that are members of Women@SCS were proportionate to reality. From our randomized set of transcripts we have focused on questions relating specifically to self-perceived confidence levels.

We also examined intra-gender similarities and differences. For this set of interviews, we randomly pooled 11 women who were active members of Women@SCS and compared them with women who were not active members. Again, we focused on questions relating to their self-perceived confidence levels.

Surveys

To gain further data, a questionnaire was created to get input from current undergraduates representing all four years. The survey was created in cooperation with Fan. The survey is attached in Appendix B. This survey was created to help gauge motivation, persistence, and confidence levels and changes over the college years. Surveys were randomly distributed in required CS classes to 139 current students (106 men, 33 women). We targeted major classes required for graduation to get students of all years.

Students who transferred out of the CS major were also surveyed to determine if confidence levels continue to play a significant factor in the decision. A separate questionnaire was created, again as collaborative effort with Fan. The questionnaire is attached in Appendix C. Surveys were sent to all transfer students who were still enrolled at Carnegie Mellon University. A total of seven transfer students responded, four of whom were women.

Findings

Transcripts - Perceived Confidence

Previous longitudinal studies showed that confidence levels amongst women in the computer science (CS) field waned during their undergraduate careers (Margolis & Fisher, Miller). Lower confidence levels led women to perform poorly in classes, or even worse, to transfer out of the major. In addition, low confidence levels may carry into the workplace or discourage women from pursuing further education. Contrary to earlier findings, Blum and Frieze discovered that most women's confidence levels actually increased, rather than "extinguished" (Margolis & Fisher, page 77), during their college years. They found that more men reported higher confidence levels which was not surprising given what we know about the general relationship between gender and confidence.

Similar to the Blum and Frieze findings, we discovered that for most of the women interviewed, confidence actually increased during their college career. A greater number of men than women replied that their confidence had increased (refer to Figure 1) which is to be expected as demonstrated through prior research (Fuller et al). What we did find that

was unique, and suggests a gender similarity, was that both men and women experienced a fluctuation in confidence during their four years in the computer science program. Students stated that although overall their confidence increased, levels varied greatly over the years, dependent on the classes they were taking. One male comments that "*I think there are varying trends in my confidence. I may feel sort of overall more confident, but I also have learned that there's far more to computer science than writing some C program. So, where as I'm more confident in doing, basically what I do well, I recognize there are a lot of parts of computer science which I know how to do them, but there are many people who are going to be far better than I*" (122). When a female student was asked if her confidence went down or up, she replied, "*It's done both of those. Decreased, increased, on the most part overall, increased*" (36).
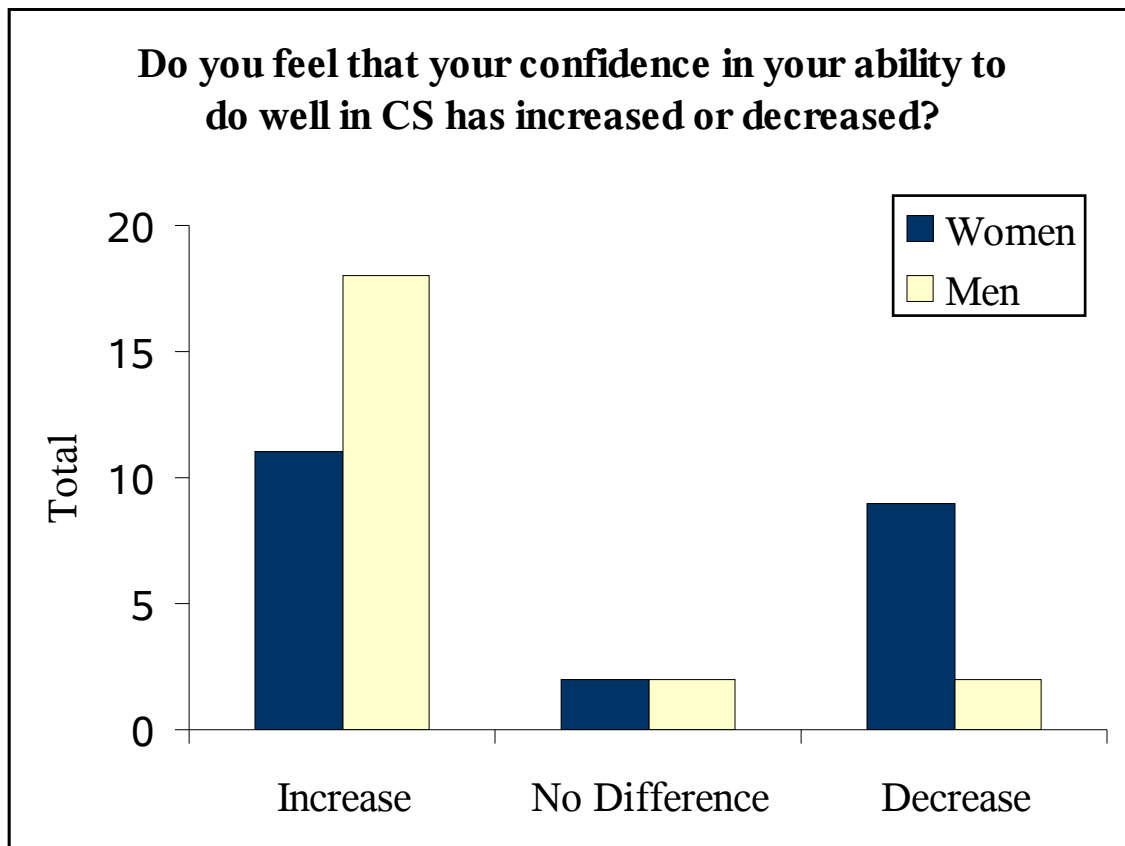

Figure 1: Response from the 2004 senior class transcripts on their perceived confidence levels.

The reasons behind the overall increase were the same for men and women. Both pointed to getting through a tough program and having practical experiences through internships and research experiences. Here we see an example of a gender similarity that could easily go unnoticed if we only focused on differences.

Students understand that the computer science program is not easy, realizing that there are many other brilliant people in the program. Increases in confidence were attributed to just simply getting through difficult classes and the program. One woman attributes her confidence increase to "*what I've learned in the classes and how well we've done and comparing that to some of my friends from other schools in computer science and just like, they don't get a chance to learn half the stuff that we are introduced to*" (36).

Men also feel that getting through the tough classes has helped tremendously. Through the classes, one student felt that "*I've learned I would say the basics of computer science and got good practice at it and leaned to apply it in these other fields I've felt more confident about that. Now if I were to be a pure software programmer I wouldn't feel 100% confident*" (138).

Involvement with research is also a great confidence booster. By applying the knowledge learned in the classroom to related research helps emphasize a student's sense of achievement. One female students talks about her research with great pride as she says, "*I went to a conference and presented this little poster on my research. Even though like I'm not doing completely novel, wonderful things, I feel much more confident in my ability to program and understand these problems and find solutions*" (261). Internship experience also helped to reinforce confidence. One male student points to his internship as an event that helped to raise his confidence. He states that by "*doing well in projects, having stuff that works, taking projects to completion*" helped tremendously as now "*I can point to that and say I did that*" (124).

Women pointed to an additional factor that helped with their confidence. Participation in extracurricular activities appeared to play a critical role in women's increase in confidence levels. Through additional activities, women gained public speaking skills and gained leadership skills. Through these other activities, they were able to point to successful points in their school career, which increased their confidence.

Both men and women experience a decrease in confidence when they realize that they can't do it all. One man told us, "*Honestly I have to say it's decreased because when I came in I thought Oh you know I would just learn all the programming languages and then I'll be the best CS student ever. But now I see there are so many different areas of CS that I would just never be able to grasp fully. It's when I thought it was a narrow field; I thought I would do well. But now that I know how big it is I'm just like well wow you know I hope can specialize in one thing and do that well you know that's the best I can get out of it*" (67). Women also experienced the same frustrations. One woman comments that, "*I think [my confidence] kind of decreased because the breadth is big… But since I know, a little bit about everything, I'm not as confident … If you knew everything about databases or everything about web applications then I think you would have a bigger confidence*" (42).

This finding is not surprising. According to previous research, we see that women tend to report lower confidence levels. This difference has been well documented through many prior studies. However, when students were asked about their confidence in specific skills, strong similarities between men and women emerge.

Transcripts - Programming Confidence

CS ability encompasses many factors; among those, the ability to program. A large part of the CS curriculum at Carnegie Mellon University requires students to spend time programming. Thus programming ability should play a role in a student's confidence in his/her CS ability. Therefore, we hypothesized that their confidence in their programming ability would be similar to a student's confidence in their CS ability.

However, when we asked if they felt that they had the skills required to be a good programmer, we found that confidence levels in their programming abilities were almost identical (see Figure 2). In contrast to the gender difference in general confidence levels we found a strong gender similarity when we looked at confidence in their programming skills.

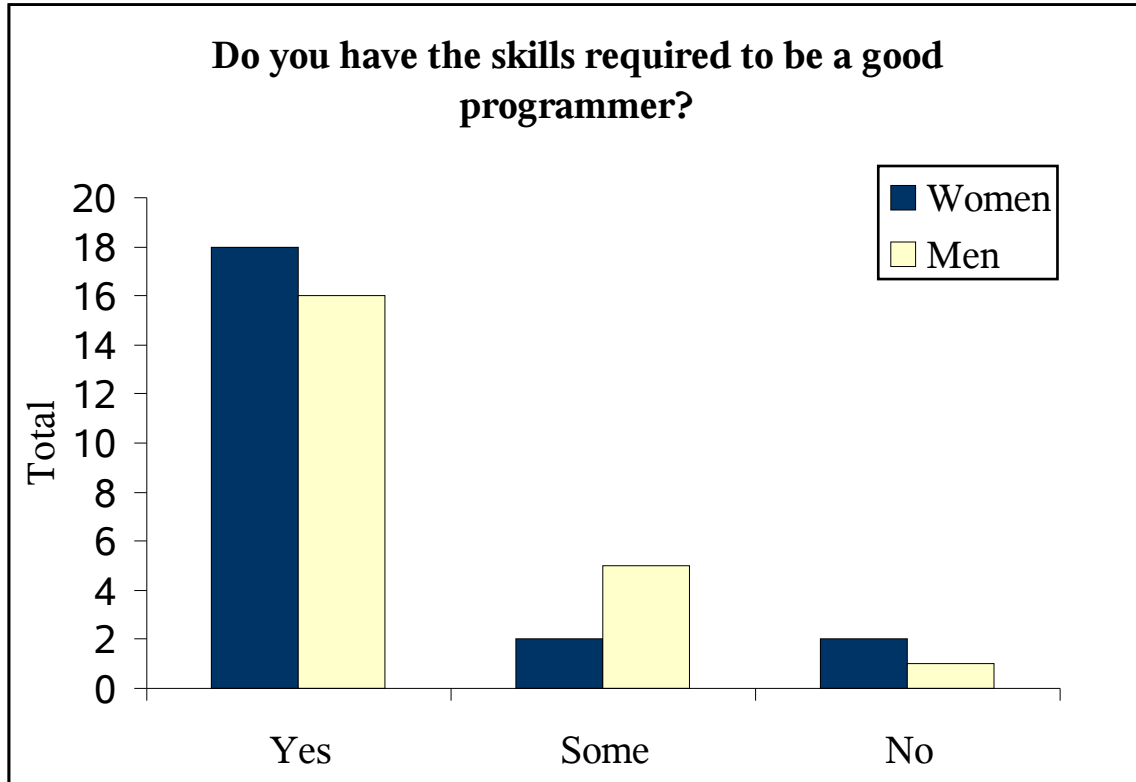## Do you have the skills required to be a good programmer?

Figure 2: Response from the 2004 senior class transcripts on their perceived confidence in programming ability.

Both men and women listed a range of skills that they felt were necessary to be a good programmer. The skills listed varied from patience to logic to organizational abilities. However, both men and women covered the same range of skills. There were no differences in the skills that were listed. Men and women have confidence in the same abilities.

This was an unexpected gender similarity. Previous studies have suggested that programming was one of the factors deterring women from entering the computing field (Margolis & Fisher). Even among women who were currently in the field, programming has consistently been listed as a dislike (Teague).

The general stereotype is that women simply do not enjoy programming. As the women in our cohort responded to the question, they felt that they were one of the few answering that they liked programming. One commented: *"I enjoy programming. (Laugh) Isn't that just it? It shocks me to admit that. Um, I really like it, um, I guess I don't really enjoy it um, on like a daily basis like, for example if I had to do it 50 hours a week I don't think I would enjoy myself. But, um, when I'm working on a project and you know, I haven't slept in a while and it's just something about sitting there even though I haven't slept and I'm tired and I don't want to do it anymore I just force myself to keep going and I really enjoy it and when it's over I'm like, oh, what do I do now?" (48).*

Our findings show that not only do women actually like programming, they feel that they have confidence in their skills to be a good programmer. Part of the confidence comes from being able to perform when asked. One woman notes that her research and internship experiences have helped to solidify her programming confidence: *"I think I've been tried and tested in a lot of different projects at CMU and in my research positions as*

well as my internships. Where frankly like you're going into many of the internships you're required to sort of pick up the language as you go along" (14).

Transcripts – Academic Skills

Another contributing factor to confidence levels in CS is academic abilities. One question asked students to list their academic strengths. Overall, we see that men and women list different academic strengths. Men tend to list skills such as their math and logic abilities. Women tend to list soft skills, such as persistence and their unique ideas, as an academic strength.

Although on a whole, men and women listed different strengths, the diversity between the answers was also great. A number of women felt that they had great math skills and a number of men mentioned their soft skills as strengths. Men and women also listed similar skills. Both emphasize their strong work ethic and their ability to learn quickly as strengths. Even amidst differences, we see evidence of how men and women respond similarly. Refer to Table 1 for more details.

What do you consider to be your academic strengths?

Men	Women
Math	Persistence
Science	Unique Ideas
Logic	Working well with others
Test taking skills	

Both
Learning quickly
Strong work ethic

Table 1: Academic strengths listed by men and women

Transcripts – Sense of Success

In terms of their sense of success, men and women reported similarly (see Figure 3). Although more men reported feeling successful, the difference is insignificant. Individuals who lack self-confidence tend to look down upon themselves. With their lower standards, they generally tend to believe they are not successful.

Men and women base their sense of success on similar reasons. When asked what makes them successful, men and women refer to their GPA, their research projects, and their confidence in their ability to do CS. From comments made by students, we see that confidence plays a role in how successful students feel. When asked if she felt successful one student responded "*definitely because it's something I was very weak at. I didn't know anything about it, and I don't think I'm excellent or stellar at it that I can do everything with it, but I know that CMU has shaped a work ethic.. .It shapes you as a person in terms of determination, assertiveness, and building confidence, and I know that the foundation that I've gotten her is excellent*" (35).

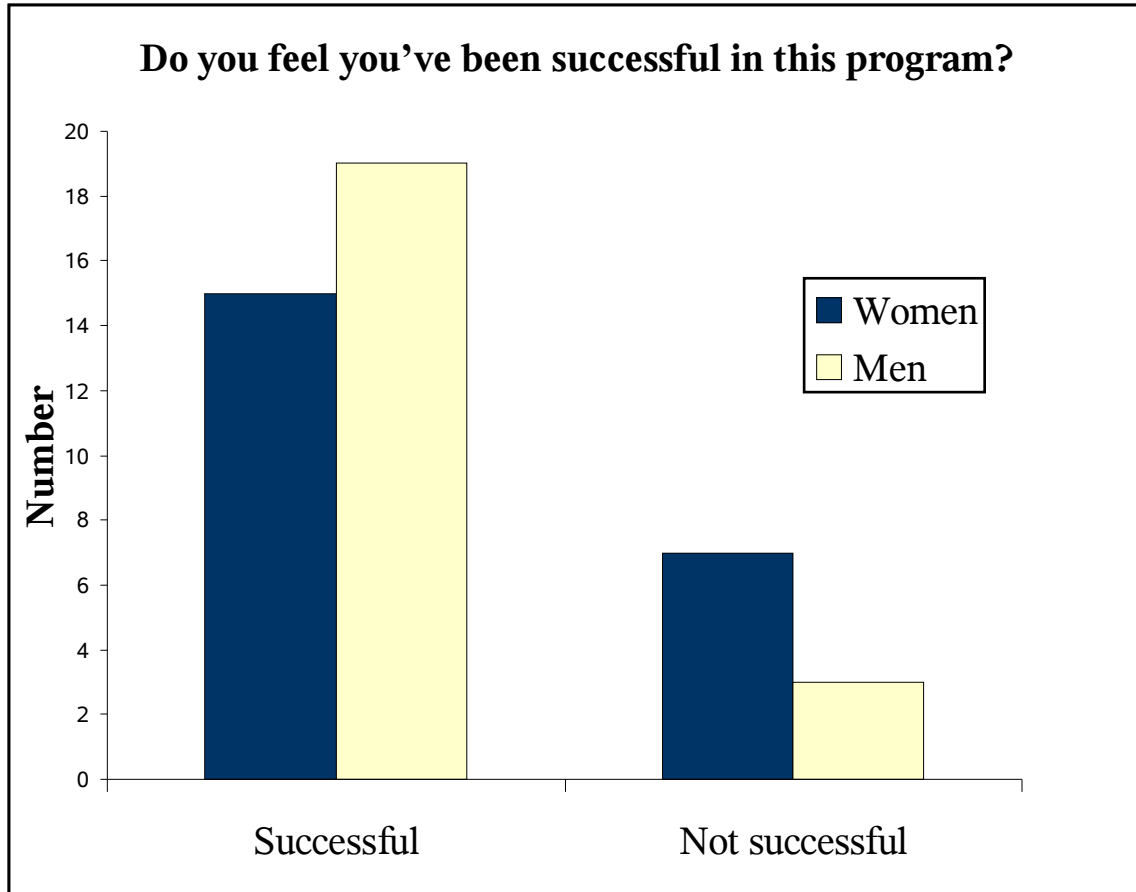## Do you feel you've been successful in this program?

Figure 3: Similar responses between men and women when asked about their perceived success levels. Although there are more men who believe they are successful, the difference is not significant.

For the most part, students based their success on their GPA. However, for many students, success encompassed other skills aside from their grades. When explaining why she felt successful, one student noted "*I learned a lot… Not necessarily, how to program, but different disciplines, different ways of thinking. And also CMU opened up a lot of doors for me in terms of opportunities to work with different companies, or meet different people. And I learned a lot of life experiences from those activities or involvements.*" (8). Many students felt successful simply because they would be graduating from CMU as one student notes. "*From my own sense I feel successful. I feel that I've conquered the classes, like you've said before it's ah you feel that you've finished something that's really difficult. So nobody could shoot you down. You're very humble I think. You come out of the program.*" (108).

In general, we see that both men and women feel very successful in the CS program. Although our findings show that there were more men that report that they felt they were successful, the difference is insignificant.

Transcripts – Social Confidence

Often times, when people think of the stereotype of computer scientists, the image of a lone male staring at a computer all day and all night comes to mind. One reason that men and women don't want to major in CS is because they want to live a balanced life

(Jepson & Perl). There is a general misconception that computer scientists cannot have other interests.

Balancing other activities can play a role in affecting overall confidence. Confidence and success is not just based on grades. Many students base their confidence and success on extracurricular activities. Through outside activities, students can gain leadership skills, presentation skills, and communication skills. These skills can also help to increase students' overall confidence levels

We found that men and women responded similarly when asked if they had problems mixing CS with the rest of their life (see Figure 4). For the most part, students found few problems trying to things aside from class work.
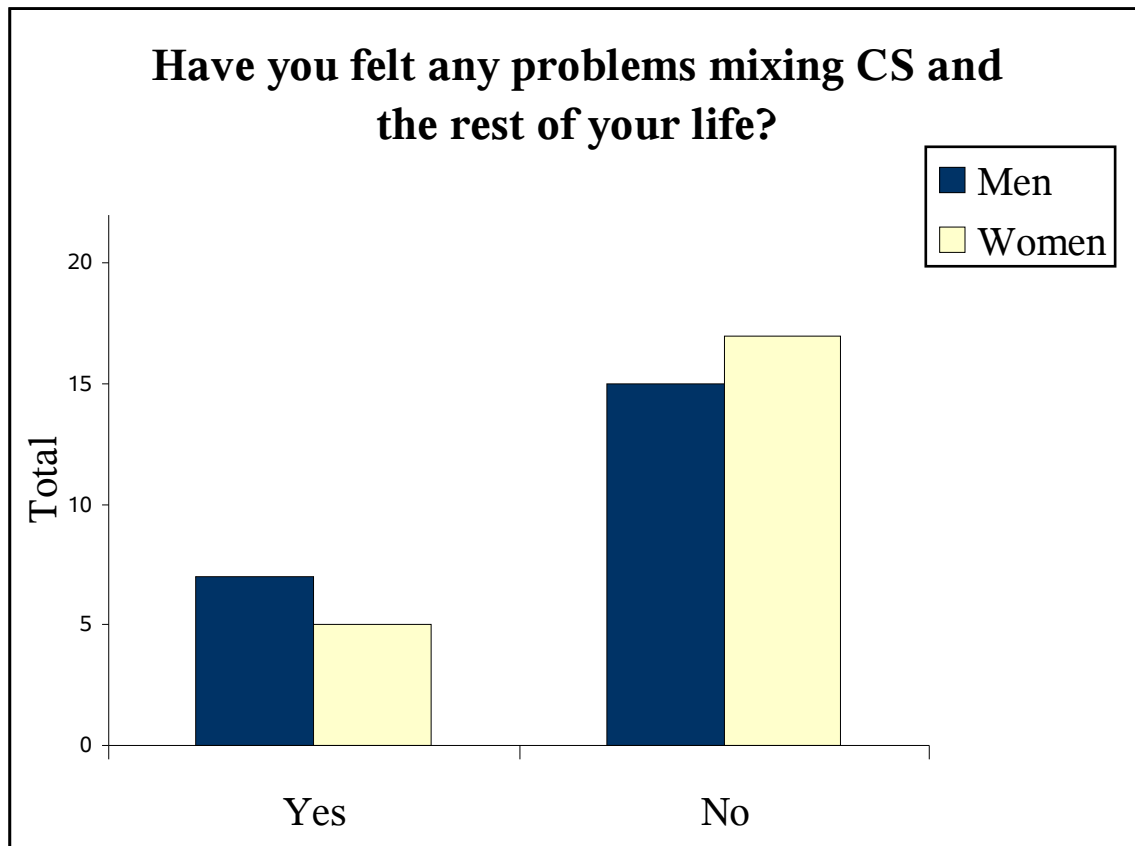

Figure 4: Gender similarity with regards having a balanced college experience

One woman, when asked if she had problems, responds "*I never had a problem with like, doing like, CS and living life. I guess there are times when you have to give up a weekend or two and like spend all weekend in the cluster but otherwise, no*" (26). Men respond similarly. "*I've never found it to be a big problem at all. I mean, certainly some semesters the work load can cause a little bit of trouble but, you know I haven't ever, I've always been able to manage to fit everything in that needed to be fit in… plus I'm in a fraternity and every spring we do booth, we do Greek sing and all that*" (100).

Transcripts – Intra-gender

The modified admissions process affected more than just the gender balance of the student body. Additionally, it brought about a more balanced breadth of interests. With the variety of interests, it is hard to group all women into one group and all men into another.

Even between the two student researchers (Chang and Fan) working on this project, differences between the individuals emerged. Chang and Fan had different background preparation before enrolling, and while at Carnegie Mellon University, the two have had extremely different experiences.

The differences began early with their background. Fan started taking programming classes as early as the fifth grade, while Chang took one semester of introductory programming her junior year in high school. This difference in background led to extremely different expectations for their future success at Carnegie Mellon University. Due to her prior experiences with programming, Fan had much higher expectations of her ability to be successful in her four years in college.

Even between these two women, we can see differences in perceived confidence levels. Chang felt that her confidence level has increased tremendously, while Fan felt a slight decrease in confidence. However, both noted similarities in what boosts their confidence levels. Both Fan and Chang agreed that helping others on assignments and getting through major classes has encouraged them tremendously.

These observations of both differences and similarities between the two student researchers spurred the examination of intra-gender similarities and differences. We examined 11 women that were active members of Women@SCS and 11 women that were not active members. Women@SCS was created to provide educational and professional opportunities for students generally taken for granted by the majority in the community (Blum & Frieze). We hypothesized that active members would be more aware of the opportunities available to them. We were curious to see if this difference would lead to other differences in their perceived confidence levels.

In general, we found that the two groups of women reported very similar experiences with regards to their undergraduate experience. Both members and non-members felt that the undergraduate environment provided ample opportunities to learn from friends. Women had no problem seeking advice from their friends or upperclassmen. Students were able to seek out help from upperclassmen and administration, whether or not students were involved with Women@SCS.

We did notice that more Women@SCS members felt that they knew about the opportunities available to them, both on and off campus. *"One of the things I also find extremely valuable is the fact that there are so many things going on around CMU. Just within CMU. And if I were not involved with Women@SCS I would now know about them. And by being a part of Women@SCS by being an active member I hear about different events going on around campus. Even like mentoring programs that are off campus that are extremely good interest to me"* (8). Although they may not have always taken advantage of the opportunities available, members knew of the various resources available to them.

Women who were members of Women@SCS reported having more mentoring, leadership, and professional experience opportunities. We hypothesized that these opportunities would contribute to increased levels of confidence. However, we found that there were no differences in their reported responses to their confidence levels in CS ability. There were also no differences in to their confidence in their programming abilities or how

successful they felt in the program. Women who were not members may have had other sources from where they learned about opportunities.

This difference in opportunities may contribute to women's ability to intermix computer science with the rest of their lives. We found that there was a slight difference on how confident women felt about balancing computer science with the rest of their life. Of the 11 active members, only two said that they had trouble balancing CS with other activities. In the non-active group, there were five women who noted that they had difficulty doing both.

The main reason listed by all the women who felt that they were unable to balance activities was a lack of time. At Carnegie Mellon University, undergraduates are exposed to numerous opportunities in all different areas. It is impossible to partake in them all; students are forced to prioritize what is important to them.

One woman notes that she was involved in other organizations which she felt were more important. "*I think it's great they've become that involved. I choose not to become involved in that organization because I preferred...I chose to become involved more heavily within a Christian organization on campus with volunteering and with trying other clubs out...Women@SCS I think is a great club... but it's just something I wasn't interested to do*" (35).

This reason may also be a reason that some of the non-members were not actively involved with Women@SCS. Students who have trouble balancing other activities may not be able to find the time to attend Women@SCS meetings. Even though they may want to and may benefit from the meetings, the limitations on their time may prevent certain students from being as active as they might want to be.

One woman said that she didn't have enough time to participate. "*I know a couple of girls who are involved... they seem to like it. I got e-mails about the events. They seem to be useful events, and they all seemed very nice. It was just one of the choices I made not to belong. I might have belonged if I felt I had a little more time*" (51).

As mentioned before, the ability to have other interests and activities can lead to an increased confidence level. Women@SCS provides a way for students to gain valuable skills such as leadership skills and communication skills. These skills all contribute to a students' overall sense of confidence.

Surveys

In order to further examine our hypothesis, we wanted to examine the current student body's perceptions. We wanted to confirm some of the findings we found with regards to analyzing the transcripts. In addition, we wanted to examine how student perceptions of confidence may change over the course of their undergraduate career. With the transcripts, we had a snapshot of perceptions of students who were about to successfully complete the program. When students realize that they are about to graduate, they may have higher confidence knowing that they made it through to program.

Students who were currently struggling with the curriculum may report lower confidence levels. We hoped that the cross-sectional view of all students would help us understand how confidence may fluctuate and change over the undergraduate career. In addition, we wanted to see if students' confidence levels decreased over the duration of their college career, as previous studies suggested (Margolis & Fisher, Fuller). We hypothesized that in the more balanced environment, we would actually see an increase in confidence from freshman year to senior year.

Survey data supported that women's confidence levels during college was not "extinguished" (Margolis & Fisher, page 77). Women still showed lower confidence than men as seen in prior studies. However, when taking a closer look, we saw that men and women were not so different after all. By examining the ratings that students assigned, we saw that although the women reported lower confidence levels, the distribution between men and women were similar. Women's distribution was shifted towards the left. For instance, we in Figure 5, we can see that about the same number of women reported a confidence level of three as men reported four. This trend is reflected the entire range. This may be a result of the social culture that women are not encouraged to have high confidence, especially in computing fields.
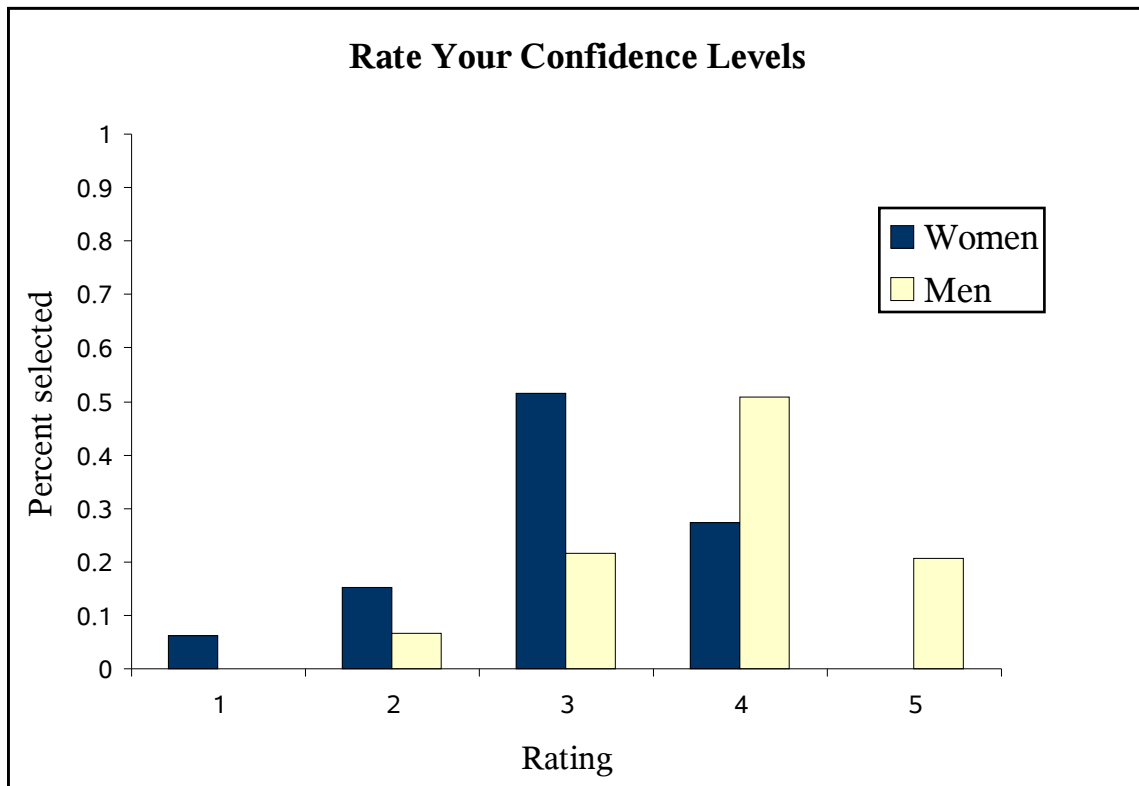

Figure 5: Confidence level (out of 5) as reported by current undergraduate students

Also, more women did rate themselves on the higher end of the scale rather than the lower end. Most women reported a confidence level of 3 (out of 5). These findings support what we saw with the transcripts. Although men are still reporting higher levels of confidence, a majority of women believe that they are fairly confident.

As we saw with the transcript analysis, women are feeling more confident. Rather than seeing confidence levels decrease over the duration of their college career, we are seeing the opposite. Underclassmen women (freshmen and sophomores) reported an average confidence level of 2.8 (SD = 0.89), while upperclassmen (juniors and seniors) women reported an average confidence level of 3.2 (SD = 0.69). We see an increasing trend among men also.

Unlike what Margolis and Fisher found, we are seeing the opposite. Students are seeing an increase in confidence as they continue in their college career. Rather than seeing their confidence drop, students actually experience a surge in their confidence levels.
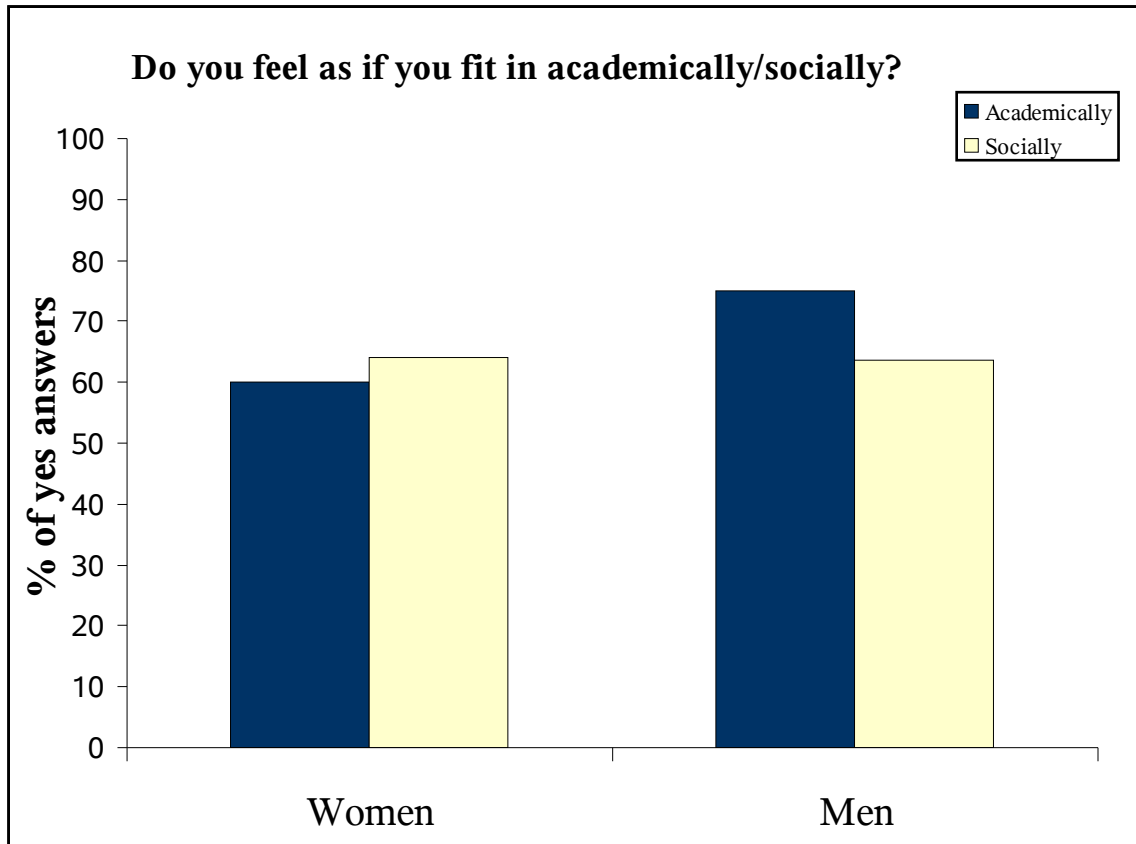
Do you feel as if you fit in academically/socially?

Figure 6: After surviving the first year, men and women report similar ideas of fitting in academically and socially in our survey

Surveys – Academic Fit

Academics play a huge role in a student's perceived confidence. Through our transcript analysis, we found that students often point to their GPA as a reason that their confidence has increased or decreased. We hypothesized that how well students fit in academically would correlate with their confidence levels.

A majority of the women responded that they had no trouble fitting in academically. However, the distribution between men and women was still uneven. That is to say, significantly more men than women felt that they fit in academically.

However, we noted that the imbalance was emerging primarily from the first year student responses and that after the first year, we saw no differences between how men and women felt they fit into the academic culture here at Carnegie Mellon University (see Figure 6). It seems that once students have been through some of the hard classes, they begin to realize that academically they have no problems. Most first year students take a data structures and algorithms course and a theoretical ideas of computer science course during the first year, both rigorous classes. After getting through these classes, students establish the "I can do it" attitude.

We noted an interesting gender difference in how students felt they compared academically with their peers. While both men and women had similar GPAs, and were

doing equally well in the program, women did not rate themselves as highly. As suggested by Barnett and Rivers, it is possible that women set higher standards for themselves.

Surveys – Social Fit

Margolis and Fisher found that the social environment played a role in affecting students' confidence levels. We hypothesized that in a more balanced environment, both men and women would feel that they fit into the social environment.

We confirmed our hypothesis and found that both men and women felt that they fit into the social environment and the computing culture at Carnegie Mellon University. Once again it appeared that the freshman responses skewed the figures as the new students were settling in. When they were included 73% of the men responded that they fit in socially and 59% of the women reported fitting in socially (see Figure 6). After the first year, both genders respond similarly with 60% of men and women feeling that they fit in socially. This provides evidence that the social environment is rapidly transforming from when Margolis and Fisher first examined the students at Carnegie Mellon University.

Surveys – Transfer students

We hypothesized that students who transferred out of the computer science major lost interest and had a decreased confidence level. Surveys were sent out to 42 transfer students that had transferred out of the computer science major since Fall 2001.   We received seven responses (3 men and 4 women). With such a small number of responses, it was hard to draw conclusions especially as our sample was not representative of the transfer students. Although students were assured of complete confidentiality, students may have felt self-conscious about responding certain questions (such as their GPA). However, we include our findings as we felt they may shed some light on why students ultimately choose to leave the computer science major.

We found that the majority of respondents had a GPA greater than 3.4. Only three of the respondents (one man, two women) had a GPA below a B average at the point of transfer. Not surprisingly these three students cited that their poor performance led to a decreased interest in the subject.

But decreased interest was not unique to students with a low GPA. The majority of the transfer students cited their decreased interest in computer science as their main reason for leaving the program. However, many note that there were just certain aspects of CS that they lacked interest in. One woman notes: *"I love the problem-solving in computer science, but I thought the programming aspect in my courses was chewing my time away"* (1). Others didn't like the theory and math involved. Often students did not realize all that CS entailed. After taking more computer science classes, they realized that they had interests in other areas, often related to CS.

For students with a low GPA, a lack of confidence also played a huge role in their decision to transfer out. One man attributed the decrease to his grades. He says, *"Getting A's (and actually understanding the material!) instead of D's and R's tends to help your confidence"* (4).   When asked about their reason for transferring, this man explicitly mentioned his decreased confidence. He said, *"I'd lost all confidence in my CS ability, and with my confidence, all of my interest in all things CS went out the window too"* (4)

A majority of the transfer students reported decreased confidence levels before transferring. Almost an equal number of men and women reported a decrease in their academic confidence when they were in the CS program. Five students (two men, three women) reported decreased confidence levels. Another woman reported a decreased

confidence in her math skills but nothing else. The same cohort reported that once they transferred, their confidence level increased. This increase in confidence may be a result of their majoring in a topic that they know enjoy and are interested in.

Findings summary: transcripts and surveys
        This study has found evidence that in a more balanced environment, the differences that we used to see between men and women are overshadowed by the similarities. By examining carefully, we found that there were many similarities between the women and the men in our cohort.
        We found that men and women respond similarly when asked about individual components of confidence. We see that women report similar confidence levels with respects to their programming abilities and their success levels. Both men and women believe that they fit in academically and socially.
        Although there are still gender differences in overall confidence levels, a majority of women are feeling more confident about themselves. We believe these differences relate more to general confidence levels as they develop in our culture rather than being specific to gender and computer science. Our study shows that women can feel confident about doing computer science and can be successful in the field.
        However, even though we are seeing an increased number of students reporting high confidence, improvements can always be made. Through the analysis of the transcripts and surveys, we have noticed some common areas which have helped or hindered students' confidence levels. Using our findings, we recommend improvements in hopes that we can continue to see improvements in students' confidence levels.

Recommendations

        By understanding the similarities and differences between the genders, we gain a better understanding of the current culture of computing at Carnegie Mellon. This knowledge may be used to further support the incoming undergraduates in their college careers.   Here we list some suggestions for enriching the undergraduate environment so that women (and men) can continue to thrive and be successful in computer science at Carnegie Mellon University.

Research Oriented Class
        Many seniors attributed their success to research or internship experiences. By requiring, or encouraging, more students to experience research, they will gain hands on experience. In addition, this experience will benefit them whether they choose to pursue a career in industry or choose to go on to further education. Research experience will help in the internship/job search. It goes without saying that research experience will help students in getting into graduate school.
        In addition, in an academically strong school where not all students can have high GPA's, research serves as another academic success that students can point to. By having a research project, students would become mini-experts in an area. They can feel as if they have an in-depth knowledge of an area of Computer Science. Also, having research would allow students to feel as if they made contributions back into the Computer Science field. One student commented after completing a project, "I can point to that and say I did that."

We understand that not all institutions have the capabilities to allow undergraduates to partake in research. We also believe that project based classes where students have an opportunity to mold an open-ended problem would be beneficial. Under the supervision of a professor, students may explore topics of interest, producing a final project of a topic that interested them the most. This class layout allows students to get a feel for what research may be like. For instance, at Carnegie Mellon, the Computer Science department offers a research based course on anonymity and privacy in data. The course is structured such that students can explore many different topics in an open ended fashion. At the end of the semester, students focus on a topic of interest to them, creating a project which they present to other students, faculty and staff at the end of the year.

Pamphlets and Website

Students often state that they are overwhelmed with the opportunities that they can take advantage of. A series of "How to" booklets would be helpful in helping students get started in certain topics such as undergraduate research, internship searches, and managing their time. Often times students are overwhelmed and do not particularly know where to start. In addition, these how-to guides can also be placed on the internet for easy access.

Research topics could be placed in a database where students can search on a topic. Currently, we provide research topics of the professors in a big packet that students often are frightened of. By making a simple web interface, students could easily search on a few key words to find professors who research topics of interest to them.

Information Session

We also believe that a key factor for retaining students' interest in computer science is for them to be involved with other activities. Additionally, involvement helps to increase a student's support group. Social confidence was mentioned as a contributing factor to a students' overall sense of confidence and success in the program.

Currently there are many organizations in the School of Computer Science that students are either unaware of or do not understand the purpose of organizations that may be of value to them. Through an information session in the beginning of the school year, we hope that we can introduce students to the various CS and engineering organizations on campus (such as Women@SCS or the CS Student Advisory Board).

Lunch and Learn

Lecture series targeted for undergraduate needs would also help students. Topics might include current research, internship opportunities, or learning about successful people in the computing fields.

Casual round-table talks about the ongoing research in the school from professors and from doctorate students would give students an idea of the breadth of the field. In addition, by learning from others, they get a chance to meet successful members of the computer science field. Moreover, talks from successful women in the field, academia and industry would help to encourage women students to continue to pursue their passions. Not many students learn about the history of the computing field. Certainly, not many people can name anyone before the nineties that has made an impact on the computing field. By providing role models for all students, they will be able to learn from other great computing leaders.

In addition, having round table discussions promotes a greater sense of community. Students get a chance to meet other professors, students (both undergraduate and graduate),

and faculty. This gives them more people to ask for advice, to discover and seek research opportunities, and a chance to meet others in the Computer Science community in a non-threatening situation.

Next year, Women@SCS plans to start implementing information sessions at many of our weekly meetings. We hope to devote half of the meeting time (30 minutes) to a topic of interest which will be led by an upperclassman. Some projected topic ideas include technical interview skills, resume workshops, and internship advice. We believe that the benefits of having such information sessions are two-fold. We hope that students will be able to benefit from hearing advice from students who have already gone through this process. They will be able to get personalized advice from their peers. Additionally, we believe that through providing valuable advice to other students, the upperclassmen will gain confidence through practicing leadership skills. By providing advice, we hope that students will be able to realize all the accomplishments that they have achieved. In addition, by helping others, it will help to reinforce the ideas that they are teaching.

Exposure

Next year at Women@SCS, we plan to invite professors to some of our meetings. Additionally we plan to invite graduate students to give a brief overview of their research area. We hope that through exposure to successful computer scientists students will be able to recognize that they can achieve success in the field. We hope that these men and women can serve as role models for the undergraduates.

Additionally, we hope that through meeting professors and graduates, undergraduates will be encouraged to continue in their studies. We believe that exposure will help students to identify interesting research areas along with providing them with opportunities to meet people who have already been through what students are currently going through.

Furthermore, we hope that they may use the professors and graduate students as another source of advice. We believe that the relationships that will be garnered are invaluable.

Conclusion

Through the analysis of transcripts and surveys, we find that the culture here at Carnegie Mellon University had undergone a transformation since the Margolis/Fisher studies. Margolis and Fisher, along with other previous studies on gender and computer science, studied an unbalanced environment where men overshadowed women. In such an environment, the differences are easy to identify. With the changes to the admissions process to emphasize students' ability to become future leaders in the CS field, we have seen a transformation of the student population at Carnegie Mellon University. In a more balanced environment, we hoped to find similarities between the genders. There will always be differences, as men and women are different, but we wanted to show that the gender differences begin to dissolve.

We hypothesized that this new environment would affect the perceptions of students' confidence level. What we found supports the Blum and Frieze findings. With a more balanced environment, the differences dissolve, and women can be seen to have confidence and be successful in CS.   Men and women have similar views of their confidence levels with regard to programming, have similar views of their success level,

and also have similar views on how they fit in to the environment academically and socially. But there are still students who are struggling with low confidence levels. We still need to pay close attention to student's confidence levels and find strategies to ensure continued success.

Strategies should focus on benefiting all students. As we found, there are more similarities than differences between the genders. By acknowledging the differences and not the similarities between genders, we may be exasperating the problem. Rather, we should acknowledge that all students are different and have a unique set of needs.

Based on our findings, recommendations were made to further improve the students' experiences in the computer science major. Starting in the fall, Women@SCS hopes to start to implement some of the ideas suggested in an effort to retain more undergraduates in the computer science program at Carnegie Mellon University. Through the recommendations made, we hope that students can continue to excel in the computing culture at Carnegie Mellon University so that these students transform into the future leaders in the field.

References

Amborse, S., Lazarus, B., & Nair, I. (1998). No Universal Constraints: Journeys of Women in Engineering and Computer Science, *Journal of Engineering Education.* (87) 4. 363-368.

Andrews, G. R. (1998). 1996-1997 CRA Taulbee Survey, *Computer Research News*. (8) 2. 6-9.

Andrews, G. R. (1997). 1995-1996 CRA Taulbee Survey, *Computer Research News*. (9) 2. 5-9.

Astin, A. W. (1993). *What Matters in College? "Four Critical Years" Revisited.* San Francisco: Jossey-Bass.

Barnett, R. & Rivers, C. (2004). *Same Difference: How gender myths are hurting our relationships, our children, and out jobs.* New York, NY: Basic Books.

Blum L. (2001). "Transforming the Culture of Computing at Carnegie Mellon". *Computer Research News*, 13(5), 2.

Blum, L., Frieze C. "As the Culture of Computing Evolves, Similarity can be the Difference".

Brush, Stephen G. (1991). Women in Science and Engineering. *American Scientist.* 79: 404-419.

Bryant R. E. & Vardi M. Y. (2002). 2000-2001 Taulbee Survey, *Computer Research News*. (14) 2. 4-11.

Camp, T. (1997). The Incredible Shrinking Pipeline, *Communications of the ACM*, (40)10. 103-110.

Cohoon, J.M. (2002). Recruiting and retaining women in undergraduate computing majors. *Inroads (SIGCSE Bulletin)*. (34)2. 48-52.

Durndell A. & Lightbody P., (1993). Gender and computing: change over time?, *Computers & Education*, 21(4). 331-336.

Felder, Richard M., *et al.*, (1995). A Longitudinal Study of Engineering Student Performance and Retention. III. Gender Differences in Student Performance and Attitudes. *Journal of Engineering Education.* 84(2). 151-163.

Fuller, H. et al. (1997). Attitude about engineering survey, Fall 1995 and 1996: A study of confidence by gender. In *Proceedings of the American Society for Engineering Education Annual Conference,* Milwaukee.

Gurer, D. & Camp, T. (2002). An ACM-W Literature Review on Women in Computing. *inroads (SIGCSE Bulletin).* (34) 2. 121-127.

Irwin, M. J. & Friedman, F. (2000). 1998-1999 Taulbee Survey, *Computer Research News.*

Jepson A. & Perl, T. (2002). Priming the Pipeline. *inroads (SIGCSE Bulletin).* (34)2. 36-39.

Kling K. C., Shelby-Hyde, J., Showers, C. J., & Buswell, B. N. (1999). Gender differences in self-esteem: A meta-analysis. *Psychological Bulletin.* 125(4). 470-500.

Kozen, D. & Morris, J. (1999). 1997-1998 CRA Taulbee Survey, *Computer Research News.* (11) 2. 4-9.

Kozen, D. & Zweben S. (1998). 1996-1997 CRA Taulbee Survey, *Computer Research News.* (10) 3. 4-8.

Margolis, J. and Fisher, A. (2002*). Unlocking the Clubhouse: Women in Computing.* Boston, MA: MIT Press.

Pearl, A., Pollack, M., Riskin, E., Thomas, B., Wolf E., & Wu, A. (1990). Becoming a Computer Scientist. *Communications of the ACM.* (33)11. 47-57.

Robinson, D.A.G. & Reilly, B.A. (1993). Women Engineers: A Study of Educational Preparation and Professional Success. *Journal of Engineering Education.* April, 88-98.

Scragg, G., and Smith, J., (1998). A study of barriers to women in undergraduate computer science. In *Proceedings of SIGCSE'98 conference*, Atlanta.

Spender, D. (1995). *Nattering on the net: women, power and cyberspace.* Spinifex North Melbourne.

Teague, G.J. (2000). Women in Computing: What brings them to it, what keeps them in it? *GATES.* 5(1). 45-59.

Vardi M. Y., Finin T., & Henderson T. (2003). 2001-2002 CRA Taulbee Survey, *Computing Research News.* (15) 2. 6-13.

Zweben S. & Aspray, W. (2004) 2002-2003 CRA Taulbee Survey, *Computer Research News.* (16) 3. 5-19.

Appendix A
Transcript used to seniors from the class of 2004.

General: 2003 and 2004 Computer Science Interviews
Seniors' Interview Project
Date: Student: senior #   , female/male

General Background
1. Did you grow up with a computer in the house?
2. Who used it most?
3. Did you have your own computer? (Tell me about that, e.g., when did you get it?)
4. When and how did you first get interested in computers and computing?
5. Why did you decide to major in Computer Science?
6. Who was most influential in your decision to major in cs?

CMU
7. Why did you decide on CMU?
8. Was coming here as you expected?
9. How would you describe the atmosphere in the CS Department now? and has it changed since you first came here?

CS Students
10. Can you describe for me the characteristics of computer science students here at CMU?
11. Where do you fit into this picture? (or not fit in?)
12. Can you remember your first impressions of computer science students? (Have your impressions changed since you were a freshman?)
13. Can you say a few words about computer science stereotypes?

Your interest in Computer Science
14. What interests you most about Computer Science? Why?
15. What interests you least about Computer Science? Why?
16. What projects are you drawn to?
17. Do you like/dislike programming? Why?
18. What skills do you need for good programming?
19. Do you have these skills?
20. Has your interest in Computer Science changed over the years?
21. Why do you think that is?
22. What do you regard as your academic strengths?
23. Are these the same as your academic likes or interests?
24. What helps you to learn best?
25. Do you feel you've been successful in this program?
26. What skills do you think are necessary to be successful in Computer Science at CMU?
27. Do you think your grades reflect the skills you mentioned?   And what have your grades been like? What is your overall GPA?
28. Do you feel that your confidence in your ability to do well in CS has increased or decreased? (what has most significantly influenced your sense of confidence?)

More about your thoughts on the Computer Science major
29. What was the best thing about doing this major?
30. What was the worst thing?
31. What has been your favorite class? Why?
32. Least favorite? Why?
33. What would you change about the CS major if you could?
35. Have you ever thought about switching out?
36. What has kept you going?
37. Were there any particularly difficult semesters? Or years?
38. Have you ever felt discouraged?
39. Where do you go, how do you handle it, when you feel discouraged?

40. Have you felt any problems with mixing CS and the rest of your life?

Women@SCS
41. Do you know about the student organization—Women@SCS?
42. What's your impression of Women@SCS?
43. Have you had any contact, been to any events run by the organization? and if not why not?
44. Has it had any affect on your experiences at CMU?
45. Do you have any suggestions for how Women@SCS can reach out to more students—men and women?
Outside of W@SCS, would you say the undergraduate program has provided or helped you with the opportunity to learn from friends?
Has the undergraduate program provided you with the opportunity to get advice?
Has the undergraduate program provided you with opportunities to increase your professional contacts?
Has the undergraduate program provided you with the opportunity to be or to have a mentor?
Has the undergraduate program provided you with an opportunity for leadership experience?
Has the undergraduate program provided you with an opportunity for professional experience?
Has the undergraduate program provided you with an opportunity to attend conferences outside of CMU?

Gender and CS
46. What do you think is the men to women overall ratio now in Computer Science at CMU?
47. Do you think CMU should make any further efforts to attract and retain more women in computer science?
48. Are you aware that there are very few women in Computer Science generally?
49. Why do you think that is?
50. Does it matter that there are so few women in the field?
51. What has it been like being a woman in cs overall? (men are asked to speculate)
52. Have you experienced any problems in the program because you are a woman? (or man?)
53. Have you experienced any advantages because you are a woman? (or man?)
54. Have you noticed any changes that might affect women? (For better or worse?)
55. Have you noticed any changes that might affect men? (For better or worse?)
56. What do you think the situation is like here in cs for other under-represented groups?—African American, Hispanic, for example?

Now that you are a Senior
57. How would you define Computer Science?
58. Is this what you thought as a Freshman? Has your conception of computer science changed since you were a freshman?
59. Looking back what have you enjoyed most about your years here?
60. What have you disliked most about your years here?
61. What advice would you give to new students?
62. Would your advice be different, depending on whether the new student was male or female?
63. What would you say to a high school senior boy or girl thinking about coming into CS at CMU?

Changes
64. Can you identify for me what changes, if any, you've noticed over the years between now and when you were a freshman?
65. Have you changed? (In what ways?)

The Future
66. So where are you going from here? and how do you see your future?
67. Would you say this is how you saw your future when you first came here?
68. What have been your experiences in the job market been like, with recruiters, etc.?
69. What is your vision of how computers can shape the future?
70. What role do you see for yourself in that vision?

Finally ☺
*Is there anything we haven't discussed that you would like to add? Anything about life in CS that we should know about?

Appendix B
Suvey created in conjunction with Fan for the current student body

General Survey

Information from this anonymous survey will be used as part of an undergraduate research project.
If you are not currently a Computer Science major, please do not fill out this survey.

Background Information

1. Gender: Male Female

2. Year of Graduation: 2008 2007 2006 2005 Other:_____

3. Current GPA: < 2.0 2.0-2.49 2.5-2.99 3.0-3.49
   3.5-4.0

4. Was CSD, CMU your first choice? Yes No

5. Did you take any CS classes in high school? Yes No

   If yes: Please specify the language(s) and the number of semester(s) studied:

   How did you obtain your programming skills? (e.g. self-taught, AP Computer Science, general study)

Interest in Computer Science

1. In just a few words, explain why you decided to major in computer science.

2. Has your interest in computer science changed since you enrolled at Carnegie Mellon?

   Increased No change Decreased

Academic Experience

1. Indicate your preference(s) for working on computer science assignments (check all that apply):

☐ Work Alone ☐ People above skill level

☐ Group of men and women ☐ People below skill level

☐ Group of only men ☐ People with same skill level

☐ Group of only women

2. Rate how comfortable you feel working with the opposite gender (1 lowest – 5 highest):
   1 2 3 4 5

3. Have you ever felt discouraged? Yes No (if no, skip to 4)

   If yes, when? Freshman Sophomore Junior Senior
   Fall / Spring Fall / Spring Fall / Spring Fall / Spring

   If yes, what has kept you going?

   If yes, why did you feel discouraged?

4. Rate your academic confidence level (1 lowest – 5 highest):   1   2   3   4   5

5. Do you feel that your grades reflect your academic efforts?   Yes   No

6. How do you feel about your abilities to do CS related topics in relation to your peers?

           Below   Equal   Above
     Why do you think that is?

7. On a scale of 1-5 (1 having low influence and 5 having high influence)
    Rate the following factors as you believe they influence your **academic confidence**:
        Grades   1   2   3   4   5
        Interpersonal Skills   1   2   3   4   5
        CS ability   1   2   3   4   5
        Recognition/approval   1   2   3   4   5
        Job/Internship offers   1   2   3   4   5
    Rate the following factors as you believe they influence your **sense of success**:
        Grades   1   2   3   4   5
        Interpersonal Skills   1   2   3   4   5
        CS ability   1   2   3   4   5
        Recognition/approval   1   2   3   4   5
        Job/Internship offers   1   2   3   4   5
    Rate the following factors as you believe they influence your **interest in computer science**:
        Grades   1   2   3   4   5
        Interpersonal Skills   1   2   3   4   5
        CS ability   1   2   3   4   5
        Recognition/approval   1   2   3   4   5
        Job/Internship offers   1   2   3   4   5

8. What are you most proud of?

9. Within the CS department, do you feel you fit in
        Academically?   Yes   No
        Why or why not?

        Socially?   Yes   No
        Why or why not?

Overall Experience
    1. What do you want to do with a CS degree?

            ☐ Job/Industry

            ☐ Academia

            ☐ Research

            ☐ Other _____

        Has this changed since you first entered Carnegie Mellon?   Yes   No

        Do you plan for further education?
            ☐ MBA   ☐ Medicine

            ☐ Law   ☐ CS Masters/PhD

☐ Masters/PhD in another field:_____   ☐ No further plan

☐ Other:_____

2. Are you satisfied with your academic experience in the CS program?   Yes   No

3. Other comments?

Appendix C
Survey jointly created with Fan for students who have transferred out of computer science into a different school at Carnegie Mellon University.

Transfer Student Survey

Information from this anonymous survey will be used as part of an undergraduate research project. Catharine Fichtner (ck3v@) will be collecting both electronic and paper responses and giving them to the research team with full confidentiality. Paper responses can be dropped off at her office, Wean Hall 5107.

BACKGROUND INFORMATION

1. Gender
2. Year of Graduation:
3. Current GPA:
4. GPA at time of transfer:
5. Was CSD, CMU your first choice?
6. Did you take CS classes in high school?
If yes,
Please specify the language(s) and the number of semester(s) studied

Please specify the means by which you attained your programming skills
(e.g. self-taught, AP Computer Science, general study)

INTEREST IN COMPUTER SCIENCE

1. Why did you initially decided to major in computer science?

2. What was your first CS class at CMU?

TRANSFER

1. When did you transfer out of computer science? (e.g. fall sophomore year)

2. Why did you decide to transfer out of computer science?

3. When did you first realize that you no longer wanted to major in computer science? (e.g. spring freshman year)

4. Before you switched out, what factors kept you from transferring?

5. Are there any changes to the CS program that might have encouraged you to stay in the major?

6. Do you have any regrets to switching out of computer science?

7. Are you still continuing studies in computer science?

ACADEMIC SUPPORT

1. Indicate your preference(s) for working on computer science assignments:
(Place an X in front of all options that apply)

.   Work Alone
.   Group of men and women
.   Group of only men
.   Group of only women
.   People above skill level
.   People below skill level
.   People with same skill level

2. Did your academic confidence increase, decrease, or stay the same while you were a computer science major? (Increased/No change/Decreased)

3. Has your academic confidence increased, decreased, or stayed the same now that you are in a new major? (Increased/No change/Decreased)

4. Do you feel that your grades reflect your academic efforts in CS?

5. How do you feel about your abilities to do CS related topics in relation to your peers? (Below/Equal/Above)

6. Why do you think that is?

OVERALL EXPERIENCE

1. What did you initially plan to do with a CS degree? (Place an X in front of your choice)
.   Job/Industry
.   Academia
.   Research
.   Other _____

Do you plan for further education? (Place an X in front of your choice)

.   MBA
.   Law
.   Medicine
.   CS Masters/PhD
.   Masters/PhD in another field:_____
.   Other:_____
.   No further plans

2. Were you satisfied with your academic experience in the CS program?

3. Other comments?