Understanding Gender and Confidence in CS Course Culture

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ABSTRACT

Women in the first systems course in Stanford’s CS core find themselves in a divided culture in which they are a minority. For these women, establishing an identity of competence becomes critical to defining a place in the CS culture and establishing legitimacy. Social factors such as gendered self-presentation and communication, rather than objective measures of ability, plays a large role in developing confidence. Only by understanding the role of such social factors can we develop strategies for creating a more inclusive CS culture in which women may thrive. Findings are drawn from surveys, interviews, and five years of enrollment data.

Keywords
Gender and diversity; Social factors in computing; Classroom issues; Women; Confidence; Gender and education; Classroom case study

Categories
K.3.2 [Computer and Information Science Education]: Computer Science Education

1. Introduction

At Stanford, CS107, the first systems course in the major taken early in the core, marks a distinct shift from the demographic composition and course culture of the introductory sequence CS106. Regarded among students as a test of whether one can handle the CS major, students who have experienced a highly-supportive, densely staffed introductory programming sequence taught on Mac and PC [7] find themselves grappling with UNIX, more difficult material, and far less personal contact with teaching staff. Though not officially designed as such, many students label the course a “weeder,” designed to distinguish “true CS majors” from the rest.

While such courses are thought to have a “disproportionately negative effect on women and minorities” [8], analysis of Stanford’s CS course enrollments over a five year period reveal that CS107 does not filter women more aggressively than it filters men. (See Figure 1.) At the same time, qualitative interviews revealed that women did tend to experience the course differently than did the men. Both male and female interviewees described a culture in which technical and intellectual challenges confronted all students. However, increasingly minority status in the course compounded women’s challenges, endangering women’s confidence and comfort with their choice to study CS [3].

Surveys taken of students in CS107 and preceding courses in the major during the time of this study give greater context to interview findings, probing students confidence and their perceptions of their peers’ abilities. Research on the course was part of a study of the first two courses in the major, CS106A/B as well as CS107’s follow-on, CS108. (See Figure 2.) Students in CS107 during three consecutive quarters responded to the surveys. A cohort of students in randomly selected in CS106A were tracked through CS108 or until they left the CS core. The students participated in guided ethnographic interviews after each course to probe their shifting attitudes towards CS, their abilities, and their peers. Such qualitative methods allow phenomena unknown a priori to surface where quantitative measures alone may offer little insight [11]. While this study details female students’ confidence in the culture of a Stanford systems course, sociological phenomena are often reflective of a broader cultural system, such as beliefs about gender difference or stereotypes of technologist in American culture. It is the researcher’s hope that Stanford’s self-analysis will trigger discussion and insights about student experiences at other institutions.

Figure 1: Analysis of enrollments found no gender difference in the rate at which men and women went on to take CS108 from CS107.
2. The CS Major: A Narrowed Demographic

At Stanford, CS107 is required of students of computer science and two related majors — a far more limited audience than the preceding courses in the sequence. (See Figure 2.)

While the introductory CS courses attract students from a broad range of majors, the students in CS107 are students focused on computing, many of whom wish “to see how much [they] really enjoy CS.”

Having narrowed its audience to those seriously considering a major or minor in a computing related field, women in CS107 are in the minority, comprising an average of about 20% of the course population in 2000 and 2001. While these women do not rate themselves differently than do men on various measures of competence, women and men diverge in their evaluations of their peers.

Upon entering CS107, female survey respondents come in just as enthusiastic as their male peers, reporting their enjoyment of computers an average of 8.4 out of 10 where men self-report it as 8.3 out of 10. (The groups are statistically indiscernible.)

The groups, however, begin to diverge in matters of comfort and confidence with computers. While men do not report their own level of comfort in using computers as significantly different than do men entering the course, women do assess their peers in the course as more comfortable with computers than they are, though men assess themselves, on average, as slightly more comfortable than their peers (p < 0.001).

More specifically, the groups diverged suggestively, though not significantly, with respect to self-ratings of confidence in solving problems with computers. Women rated their confidence an average of 7.7 out of 10 while men rated it 8.4 out of 10. Significant differences did emerge when students’ confidence self-ratings were compared to their evaluations of peer confidence. Women rated themselves an average of a half point less confident than their peers in CS107 while men rated themselves as an average of six tenths of a point more confident than their peers in the course (p < 0.001). These findings are consistent with those of Zappert and Stansbury, who reported that among graduate students in engineering, women tend to underestimate their abilities while men tend to overestimate theirs [13].

Despite these divergences, we could not conclude that females entering CS107 report themselves as more or less likely to major in CS than do their male peers. Out of a 10 point scale, males’ average likelihood to major exceeded that of women by only 0.15. Though Margolis links confidence to propensity to major [5], χ² tests showed no correlation between likeliness to major and either self-rated confidence or confidence in comparison to perceived peer confidence on entry into CS107.

3. Choosing CS, Choosing a Cultural Role

It is in CS107 that course culture significantly diverges from what students consider a normal cross-section of Stanford culture. While most students interviewed in earlier courses described their peers as roughly representative of university students as a whole, students interviewed in CS107 described a very divided culture unique to CS.

The “tribes” described by students, however, were based not on skill but on behavioral attributes. One sophomore female who chose to major in CS broke her classmates into two groups: those who struggle and those who do well. She went on to explain that students tended to band together with those like themselves in the course. The tribes, however, did not exist in isolation from one another. All students described social contact with students they considered to be at a level different from their own.

The main differentiating characteristic between students in the two groups, however, was ability to cope with stress productively, rather than mastery of the material or prior experience. “People who don’t do as well start debugging without knowing what’s wrong with it. If something bad happens [to me], I don’t get stressed. I don’t struggle,” she explained. For her, the primary distinction between the two groups was not “those who know the material and those who don’t;” but instead, those who can handle the stress and those who cannot. Her observation echoes other works, unknown to her, establishing the importance of psychological factors in programming [12].

A sophomore male who chose to major in Symbolic Systems grouped students in CS107 somewhat differently, though behavioral factors remained most important in classification. To him, the class consisted of “hardcores,” “regular people,” and those that were “talented.”

To this student, to be “hardcore” was to be willing to devote an extreme effort to coding. “Hardcore people are the ones with a dozen diet coke cans lined up empty on their desk. They’ll tell you, ‘I spent a ridiculous amount of time on this program. It’s frickin’ impossible.’ But they have a big smile on their face,” he explained. He noted that “hardcore” was the province of males, not by any inherent gender difference that he could explain, but at least by coincidence. To be hardcore, however, was not necessarily the same as being talented, though there were some whom he would designate as both.

Others students shared a consciousness of the word “hardcore” in a way they did not in CS106. “People in 107 are a lot more hardcore than people in the 106es,” commented a sophomore woman mid-quarter.

The word “talented” described students who were perceived as having superior efficiency in completing the requirements of an assignment. Referring to assignments that can typically take 20 hours to complete, the student explained, “Getting it done in 10 hours makes you really talented. There are people who look calm and are going. You don’t see them stop typing. They seem to know what’s going on in class.” The importance of a calm façade recalls the observations of the sophomore female who cited propensity to panic as the primary differentiator among her classmates.

4. Coding Speed and Social Bias

All students in the cohort described time, or coding speed, as the fundamental measure of ability. While this mapping is not unique to CS107 — students referred to it from the first course in the core — the construct assumes a greater importance in CS107 for two reasons. First, individualized feedback from TAs is reduced to written comments on the assignment and grade distributions are not very broad. Thus, students have insufficient information by which to judge their relative standing in the class. One sophomore male explicitly stated that grades become less important in the
face of coding speed as a measure of ability. While students cited speed as a measure of ability as early as CS106A [3], it became especially critical in CS107. Not only are students, according to entry surveys, at a juncture where they are judging whether or not CS is appropriate for them but they are also organizing themselves as members of subgroups in a newly divided peer culture.

Self-comparison is a hot topic among students. All interviewed described how they compared to various peers. Students establish reputations for relative “talent” among themselves. Such status breeds anxiety among many students. “I’ve been feeling like I can’t do CS lately. I don’t think I’m good enough at it. The time I spend in 107 is so much more than other people in 107,” confesses a sophomore female who felt self-identification as a CS major in crisis at the end of CS107.

Though carrying the sheen of objectivity, perceptions of coding speed are biased by variations in accepted norms of self-report and self-display. A sophomore male admits, “I’ll say ‘I’m done’ where it is not complete but it’s done,” referring to the fact that he considers himself less “insane about code quality” and will turn in his projects short of completion to specification. The sophomore female frustrated with her coding speed says that she turns in her programs complete to specification and to her “it seems like [others do as well].” If her classmate is to be believed, her assumptions are misguided.

In fact, the recipient of a self-report of coding speed must decode that description as they would any message of social significance. Translating across gender lines, however, is not trivial. Linguistic theory suggests that gender differences exist in the motivations and forms of expressions. Linguist Deborah Tannen shows that women tend to downplay their certainty while men downplay their doubts [11].

For many of the students, this is the first time they have been immersed in a male-dominated environment. For many of these women, translating “male talk” has never been more critical. Women refining their identities and roles in the culture of CS107 — an identity that can influence their feelings of validity as CS majors — have few women to look to as reference points in determining their status within a course. Simply comparing their experiences to those of other women does not provide a sufficiently large base on which to build their confidence. Thus, women working to discern feelings of identity, confidence, and competence must translate and incorporate men’s self-reports as well. For many of these women, their interpretations will influence decisions in which their college career and possibly their entire lives are at stake.

By CS107, the realization that perception of coding speed is partially a social construct is not critical for all women. One sophomore female CS major from Japan has excellent grades and is one of the best coders among her friends. She admits, “if my grades were lower, I would rethink. But I like CS and I do well.” Another sophomore female in CS107, an EE major aspiring towards a finance career, denies awareness of a role in any course. She insulates herself from contact with peers in the course by seeking support from a sorority sister who has taken the course before. Furthermore, believing that she is cut out for CS is not important to her sense of self. As a result, she has less at stake in decoding peer speech or establishing her role in the peer culture.

The female sophomore at crisis point, however, has plenty at stake. After describing her frustrations of not “coding as quickly as the others” in her CS107 exit interview, she begins to notice the disconnect that sometimes exists between self-report, face value, and reality. “It seems hard to find guys in CS who will willingly admit that they’re not that good at CS. I have friends who are like ‘that program is so easy, blah blah blah’ but I know they spent a lot of time on it. Just a few of them.”

As the above student begins to realize, gauging performance based on evaluations of peers’ confidence can be misleading for women. In the CS107 exit survey, students were asked to rate themselves and their peers in comfort with course materials on a scale of 1 through 5. While males and females did not rate their comfort as significantly different, women rated themselves, on average, 0.3 lower than their peers in the course. Men rated themselves 1.15 higher than peers in the course (p < 0.05).

Grades in CS107 do not explain the difference in self-confidence. In 2000, women attained an average grade of 3.3 out of 4 in CS107, and their male peers attained an average grade of 3.34 out of 4. In 2001, women attained 3.19 and men attained 3.16, both of 4. Thus women who are unaccustomed to modulating men’s presentations of confidence expertise will likely underestimate their own competence.

Yet when choosing among identities available and valid in CS culture, feelings of competence are critical to women convincing themselves to identify themselves with the field.

5. Being Hardcore: No Girls Allowed

The role of the “hardcore” is complex, yet well-established in CS student culture. Whether admired or scorned, students universally associated with CS identity. One student who does not consider himself hardcore derided the hardcore lifestyle, decoupled it from true CS ability, and yet he elevated the status of hardcore students, admitting, “There’s actually a lot of it in CS. You want to be ‘hardcore.’”

Another student, a sophomore female, describes hardcore students with awe of their commitment to the course: “People are a lot more hardcore in CS107. It’s getting down to the majors and minors. I knew for a fact that a lot of people would skip [other classes they were taking] to sleep and just go to 107 at 9 am. [The UNIX cluster] was so full I couldn’t find a computer sometimes.”

The sophomore male who most carefully defined “hardcore” in his interview cautioned, “Hardcore kids are in danger of seriously burning out...But maybe you do need to be hardcore to get through the CS classes. The old CS kids I know are ones who are hardcore or were hardcore when they were freshmen. They’ve mellowed out a bit.” Interviewees described two primary images of valid CS majors: the calm, talented coder, and the “hardcore kid” who has a hard time but has a good time doing it. Those who perceive themselves as less than “naturally” talented and do not consider themselves to be “fast” enough often relegate themselves to the status of “not being cut out for CS,” as one sophomore girl did.

As one student in CS107 reports, however, the “hardcore kid” is typically male. Hegemonic gender beliefs are far less
supportive of women who stay glued to their computers and act in a single-minded, obsessive manner than they are of men who act that way. These general gender beliefs also expect men to hide strain or difficulty. One explanation of a masculine cult of “hardcore” may be that they are students who may struggle with the material but enjoy it, or at least feel compelled to act like they do. In our gender system, men have an incentive to spin their struggle into a rite of passage and endurance. Women in our culture do not experience the same expectation. Thus, it is not surprising that no woman in the cohort expressed a desire to be “hardcore.”

6. Proving One’s Self in a Gauntlet

If women generally do not accept the “hardcore” image of a CS major, then the high-ability alternative is the only one available for them to strive for. The pursuit of this self-concept is complicated with obstacles such as stereotype threat and tokenism faced by minorities subject to stereotypes. The development of a highly competent self-image, however, is critical. One sophomore female strives for but fears she falls short of that marker. “I just want to make sure I’m making the right decision. I like CS. I can’t see myself doing anything else. I’m not interested in other things. But in terms of ability, I’m not sure I’m there.” Her devotion to CS does not suffice as validation of her choice of major the way it does for some of her male counterparts.

6.1 The Latent Threat of Stereotypes

Awareness of stereotypes can depress performance in the students who struggle most for legitimacy. Claude Steele’s work in stereotype threat found that for women who identify themselves with a particular domain — in his study, mathematics — cueing stereotypes of women that threaten their status or expectations of success in mathematics depresses their performance on standardized math tests [9].

It is not the case that all women accept Western stereotypes that women are less suited for technical fields. However, all women interviewed expressed an awareness of the stereotype. The sophomore international student from Japan admitted, “There are much fewer women in CS than men. Maybe in looking for a job, I’ll see the difference. Right now, I don’t.” By “the difference,” she was referring to the potential for women in CS to be treated differently by their male peers. The very fact that she discounts the effect of stereotypes is underpinned by an assumption that she is aware of such stereotypes, at least in the United States.

However, the sophomore female questioning her ability despite her interest cites her desire to overcome looming stereotypes “that women are more suited towards fuzzy majors and males more suited for techies” as a reason to find a mentor in Stanford’s Women in Computer Science (WICS) group.

The stereotypical roles hypothesized to negatively impact the performance of women in computer science [6] first become apparent in CS107. While students in earlier courses describe a broad cross-section of course mates, CS107 students describe a subculture of “geekiness” previously evident only in an accelerated introductory programming course taken students with prior experience. This subculture gains an opportunity for visibility because of CS107’s use of the UNIX operating system, only familiar to a very small subset of students. The image of this “geek” subculture is one of male hackers and, thus, its salience implies the stereotype that women do not do computers — either out of disinterest, greater interest in people, or, at worst, technical ineptitude.

The mere existence and cueing of the stereotype, rather than any belief in it, is sufficient to hamper performance. While this study had no means of evaluating the effect of stereotype threat on women, the high likelihood of a depression in performance seems especially threatening to those whose primary means of validating their identity as CS majors is ability over interest.

6.2 Tokenism and the Minority Experience

As women’s representation among the CS107 student body hovers at roughly 20%, they gain a level of visibility not experienced by males in the class as they are “visibly different” from the majority.

Sociologist Rosabeth Kanter identified four phenomenon faced by highly-visible minorities [4]:

1. Individuals are memorable because of their difference,
2. They tend to be viewed as representing the category to which they most visibly belong, giving their actions socially symbolic consequences,
3. Characteristics that differentiate the token from the majority, such as appearance, distact the majority from recognizing less discrepant characteristics such as performance,
4. They felt pressure to keep the dominant group from looking bad for fear of retaliation.

All four risks described above are ones that may be faced by women studying computer science in a gender-skewed environment. By CS107, however, the politics of appearance had already surfaced as a topic on the minds of students. An open-ended conversation themed “Why does being a woman in computer science matter?” observed at a meeting of Stanford’s Women in Computer Science (WICS) organization quickly evolved into a discussion of how appearance affected women’s reception among their peers.

Two women who had just completed CS107 complained of the pressure they felt to dress down. The pressure was not explicit or externally applied, but instead implicit — a consequence of the women’s perception that more feminine clothing both increased visibility and distracted peers from their technical skills. The laid-back style that the some CS106 women in the group viewed as a liberation from pressure to appear fashionable grew into a burden just as constraining as the style being escaped as women’s numbers dwindled and their token status increased.

Even if women reduce the femininity of their clothing, Kanter predicts that other social skills stereotypically ascribed to women, such as emotional nurturing, overshadow and distract from their domain relevant skills and traits. The end result, according to both Kanter and the upper-division women in the WICS forum, is that women felt they had to work harder to have their traits and talents recognized. Kanter’s work, however, implies that in struggling to have their competence recognized, the minority already has confidence in their competence. For women developing their self-concept at this critical juncture, there exists a feedback loop in which technical interaction and acknowledgement are affected by and can affect an individual’s confidence in turn.

Certain aspects of CS107 and Stanford culture can dilute the consequences of visibly different social groups. In
particular, home bases such as dorm social groups and the presence of a central 24-hour lab where many CS107 students work provide compelling reasons for students in the course to positively interact across otherwise divided groups.

One sophomore female, self-described as being at “a crisis point,” cited her dorm companions in the course, both males, as her primary source of support during the course.

The presence of the UNIX cluster provided a site for CS107 students to become bonded through “common fate,” a term used by sociologists to describe conditions in which the outcomes of individuals are interlinked [1]. A sophomore female contrasted her experiences programming in her own dorm room in CS106 with programming in the UNIX cluster during CS107. “I programmed in [the central UNIX cluster] and I'd meet a lot of people,” she explained. “Sometimes I'd help people find bugs and it was a chance to learn that I was on the same level as others.”

Perceptions of common fate, perceived interdependence, and actual interdependence, as well as distinctive shared experiences, have been shown to lead to collective identities [1]. The helping student’s experiences in the computer cluster engaged her and others in a shared identity as CS107 students which then accentuated the student’s similarities with her peers. Such shared a group identities have been shown to engage in cooperative rather than competitive behavior [2].

Not all Stanford institutions encourage such beneficial interactions. One sophomore female cited fears of inadvertently violating the honor code as an impediment to feeling comfortable helping and being helped by her peers.

While some students find comfort in reaching across boundaries, others create an “ingroup” which isolates them further. For a group of sophomore females in CS107, a base for cooperation came by strengthening their as part of a gender minority in CS107. Typically working in a group in the computer lab, they formed a support network. The women’s identification with the ingroup fueled a continued sense of isolation from other students.

7. Conclusion

That CS107 does not filter women more aggressively than it filters men is surprising, given the cultural frustrations, as well as the obstacles to self-confidence and identification as CS majors. Perhaps the investment of three quarters into CS at the completion of CS107 makes this already self-selected group of women unusually reluctant to leave without giving CS108 – a Java OOP group-project based class with a reputation for being more fun – a chance.

However, students’ confidence has direct effects on their likeliness to challenge themselves in courses, research, and graduate education. By turning a critical eye towards course culture, educators can build institutions that account for the obstacles faced by women establishing their identity in CS.

Providing frequent, reliable feedback about students’ progress can also reduce the need students feel to judge each themselves by “measures” like perceived coding speed, which are subject to biases. In earlier courses in the sequence, reputations are kept in check through close, frequent contact with undergraduate section leaders at Stanford.

Successful approaches must encourage cooperation that replaces self-presentation with demonstrated ability, without diluting an individual student’s ability to be proud of and confident in their own accomplishment. Such cooperation may also encourage crossing of social boundaries.

Workshops on group and individual communication can also improve CS students’ ability to communicate effectively and inclusively. One such workshop was Stanford WICS’ most well-attended event, attracting both men and women.

Only by paying close attention to the social factors influencing students’ confidence can efforts to increase diversity in CS be successful in serving both students’ and the field’s best interests.

References


