Using departmental surveys to assess computing culture: Quantifying gender differences in the classroom

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Abstract

Male and female students often hold different views of the culture within the same computer science department. These differences may, in part, account for why women are underrepresented in computer science. We found that surveying students about their views of our departments' environments was an important first step in evaluating the cultures of our own departments, in determining what issues needed to be addressed, and in determining how to address them. Our survey results revealed some problems in our classroom and lab environments, and showed that male and female students hold very different views about our departments. We describe a set of changes that were implemented in response to our findings. These solutions are specifically designed to address problems that we discovered through our student survey, but they are not all original to us. The contribution of our work is in demonstrating how surveying is critical to identifying and understanding problems in our departments. We argue that a process of continually surveying students is vital to the maintenance and evolution of a healthy computer science program.

1 Introduction

Margolis and Fisher, in their recent book *Unlocking the Clubhouse: Women in Computing*[6], did an extensive examination of the culture of computing at Carnegie Mellon University. In the final chapter, they discuss the implications for other institutions and suggest that a first step to attracting and retaining female students is "to take the time to survey the local landscape, talk to students and faculty (perhaps through a non-threatening third party), and prioritize interventions that focus on the most urgent local issues[6, page 141]".

In keeping with these suggestions, we developed a survey to assess the state of our departments and to better quantify any problems that needed to be addressed. Results from the survey showed that students often had a different perception of the classroom and lab environment than professors had, and that male and female students often had different reactions to the same observed behaviors in the classroom and lab. We instituted changes in our departments based on the results of our survey. We plan to continue to use the survey to evaluate the state of our departments.

We found that a survey is a valuable tool for understanding the state of a department because students are often reluctant to discuss issues related to classroom environment with professors, particularly if their issues concern interactions with faculty and other students. In addition, because some students may view the current classroom and lab dynamics as "just the way things are", the act of taking the survey allows students to question the status quo. The best way to get a clear picture of how students feel about the department, and to quantify these results, is by conducting an anonymous survey of all students taking classes in our departments. An unanticipated benefit of the survey was that students became more comfortable talking to us about issues they had with the department; by conducting the survey, we showed that we were genuinely concerned about improving our department and truly interested in hearing and addressing students' concerns.

This paper first explains the current situation at our two institutions. Next, we present the survey and discuss how we developed the questions. We then describe and contrast the survey results at our two institutions. Finally, we discuss the changes we are implementing in response to the survey's findings.

2 Situation at Bryn Mawr College

Bryn Mawr is a small, highly selective, women's college. In 1999, Bryn Mawr added computer science to the college's undergraduate academic programs. We offer both a major and a minor in Computer Science. We are currently engaged in the expansion and design of the program. Margolis and Fisher reported that a major factor of female disinterest in computer science is the fact that female orientation and concerns about computing differ from the design of most computer science curricula. They claimed that universities have historically developed computer science courses with a male bias. Thus, even the introductory courses in computer science are built around "male preferences" focusing on very technical aspects from the very beginning. Further, based on interviews of over 100 female college students, they concluded that the female expression of lack of interest in computer science is really based on lack of confidence[6].

While there exist prescribed and authoritative guidelines for a curriculum in computer science (the ACM has announced a new basis for computer science curricula[2]), we are designing our curriculum in an extremely independent and deliberative manner. This is partly in response to the findings of Margolis and Fisher, but largely based on our own experiences at Bryn Mawr and similar findings at other universities. At Bryn Mawr, we are taking the challenge of engaging women in computer science as our primary concern. Our computer science curriculum uses several design considerations that go beyond the specific guidelines prescribed by standard curricular documents. While these *patterns of curriculum design* and the motivations underlying them are detailed elsewhere[4], we are also involved in an ongoing evaluation of the changes we are incorporating in our curriculum.

While Bryn Mawr is a women's college, it forms a collaborative consortium with two nearby colleges: Haverford College and Swarthmore College, both of which are coeducational. Students at these three colleges can enroll for courses on any campus. This situation is particularly well exploited by students at Haverford and Bryn Mawr as these two institutions are much closer to each other than Swarthmore College. Consequently, computer science courses at Bryn Mawr college routinely include a healthy percentage of students from Haverford College, most of whom tend to be male. Thus, issues surrounding gender differences are a concern at Bryn Mawr College as well.

Our goals for the survey are to monitor the gender attitudes in our program and also to keep a running tab on the evolution of our new program as we continue to incorporate more gender sensitive design patterns in our curriculum.

3 Situation at Swarthmore College

Swarthmore is a small, highly selective, coed liberal arts college. Swarthmore College created a provisional computer science program in 1984, with a single full-time faculty member. The program was converted to a permanent department in 2001 and now has four full-time faculty members. Over the past 18 years the department has grown significantly from enrollments of 30 students per semester in 1984 to 120 students per semester today. We offer both a major and a minor in Computer Science.

During this period of rapid growth, the faculty began noticing a change in the departmental culture from a friendly, collegial atmosphere, where all the students knew one another, to a gradually more impersonal and competitive environment. A number of students, especially female students, began to complain of other students' aggressive behavior in the classroom and the departmental labs. We became concerned that this change in the departmental culture would tend to discourage the women and minority students that we hoped to attract to our department.

Our goal for the survey is to discover the causes of this less collegial atmosphere and to implement changes that will improve the environment for all students. We plan to continue using the survey to determine whether the changes we implement will have a positive effect on the students' attitudes.

4 The Survey

The survey we developed is listed at the end of this section. It is divided into three parts. Part A collects information about each student, such as CS courses taken, class standing, gender, and whether the student had already chosen or was planning to choose CS as a major or minor. Part B quantifies how the students view the CS department relative to other departments at the institution in terms of rigor, amount of class participation, comfort in class participation, and interactions with the faculty. Finally, Part C gives the students a more open-ended forum for discussing any positive or negative observations about the department.

Writing the survey questions proved to be more difficult than we expected; it took several attempts to write questions that did not reveal our views about our departments. The resulting questions are deliberately general and open-ended, to ensure that students are not led to certain answers. In addition, we wanted to be sure we were not implying that we thought there were problems in our department.

CS Department Survey
We would like to hear your opinions regarding the state of the CS department. Please do not put your name on these; we want them to be anonymous.

Part A: Personal data

1. The highest level CS course I have taken (or am currently taking) is: a) CS1 b) CS2 c) CS3 d) one course above CS3 e) two or more courses above CS3
2. I am a: a) freshman b) sophomore c) junior d) senior
3. I am: a) female b) male
4. I am, or I'm thinking about being, a CS major or minor: a) yes b) no
5. We think that there are many good reason for students to take CS courses who are not, nor plan to be majors, however, if you answered "no" to the previous question, we would like to hear why you are taking a CS course.

Part B: Ratings

1. Compared to other courses at this institution, CS courses are how intellectually rigorous? a) much less rigorous b) less rigorous c) about the same d) more rigorous e) much more rigorous
2. Rate the amount of class participation in CS classes to the amount you think there should be ideally. a) much less b) less c) same d) more e) much more
3. How comfortable do you feel participating in CS classes as compared to how you feel participating in non-CS classes at this institution? a) much less comfortable b) less comfortable c) about the same d) more comfortable e) much more comfortable
4. The quality of your interaction with CS faculty (in class, during office hours, etc.) as compared to other faculty at this institution has been: a) much worse b) worse c) about the same d) better e) much better

Part C: Short answers

1. Is the CS lab an environment that is conducive to working on CS assignments? What are good and bad aspects of the lab environment?
2. What do you think are some good things about the department?
3. What are some things that you would like to see improved about the department?
4. If there are things that you would want changed, in what ways could these changes be implemented?

5 Survey results

We present the results from survey data collected from every CS class offered during the spring semester of 2002 at both institutions. The number of Bryn Mawr students responding was 39, 10 males and 29 females. The number Swarthmore students responding was 94, 64 males and 30 females (we did not include 25 students taking a CS course for non-majors). These numbers represent about 4% of the student body at Bryn Mawr and about 8% at Swarthmore. We are not claiming that our results are representative of all other institutions, although we think that these types of comparisons would be interesting. Instead, we are presenting the results from our institutions and describing what they show about our institutions. In Section 6, we describe how we used the results to institute changes in our departments.

In analyzing the survey results, we coded the responses to the Part B questions so that (a) through (e) equated to 0 through 4. For example, to question 3 in Part B about comfort in class participation in CS classes as compared to other classes, 0 = "much less comfortable", 1 = "less comfortable", 2 = "about the same", 3 = "more comfortable", and 4 = "much more comfortable". In all four questions of Part B, a 2 is the neutral response, meaning that the student does not perceive a difference between CS and other departments.

The survey results for both Bryn Mawr College and Swarthmore College are shown in Figure 1. The bars in the graph represent the mean values of the coded responses. Overlaid on the bars are 95-percent confidence intervals on the means. Considering the Swarthmore College results first, the graph shows that female and male students have different perceptions of the department. Women believe that computer science is more rigorous than do men. Women also believe that there is less participation in CS classes than there should be ideally, as compared to men. The most significant difference between women and men, however, is in their comfort level in class participation.

For Bryn Mawr College, the graph shows that men and women students share more similar perceptions about the CS department. The only significant difference here is that women, again, feel less comfortable participating in class than men. However, the discomfort of Bryn Mawr students is not as pronounced as that of Swarthmore students. Interestingly, the Swarthmore men were also less comfortable participating in class when compared to the Bryn Mawr men. These data suggest that the ratio of male to female students in a classroom affects the comfort level in participation for *all* students, regardless of gender.

Margolis and Fisher note that "female students in technical disciplines, perhaps partly because of their 'outsider-ness,' are especially vulnerable to poor teaching, inhospitable teaching environments (such as large classes), and unhelpful faculty" [6, page 83]. Interestingly, men and women students at both Swarthmore and Bryn Mawr rated their interaction with the CS faculty as better than with faculty in other departments, so it appears that the faculty are not the main issue here. The responses received in Part C of the survey indicate that a key problem at Swarthmore is other aggressive students, who tend to dominate the classroom and the lab.

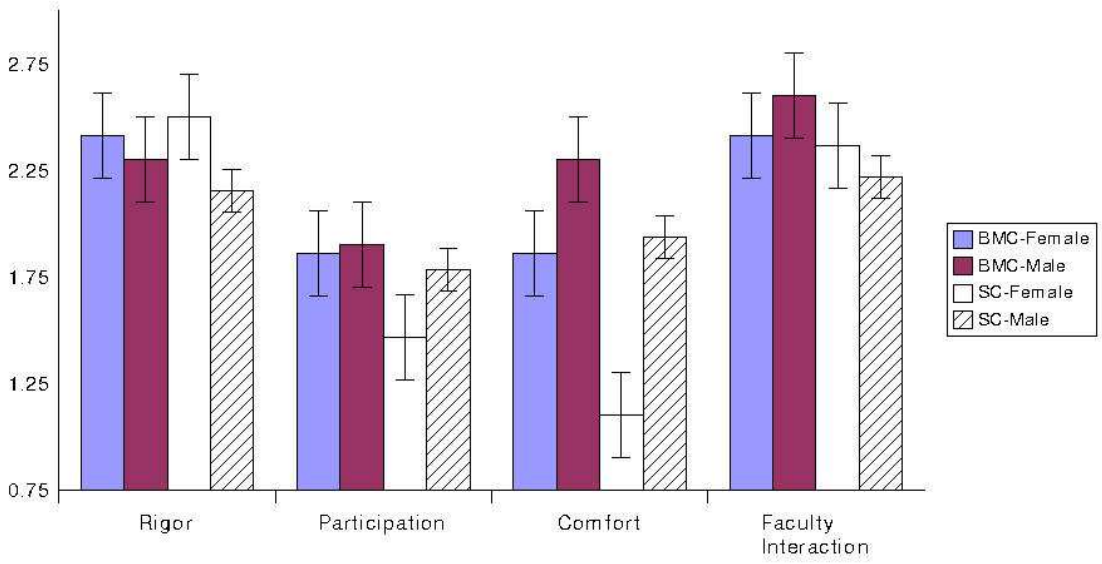

Figure 1: Mean responses to Part B survey questions at Bryn Mawr College and Swarthmore College. The X axis represents the survey question, and the Y axis represents the mean response to the question (with a range of 0–4, and 2 being neutral). The data was collected during the Spring semester 2002. The total number of Bryn Mawr students responding was 39, with 10 males and 29 females. The total number Swarthmore students responding was 94, with 64 males and 30 females.

Both male and female students identified the aggressive, domineering behavior of some students as a problem in class and in the lab. However, it did not appear to be a factor in male student's comfort levels, while it did appear to be a factor in female student's comfort levels. We found it interesting how differently students and faculty perceived this type of aggressive behavior. Some students, females in particular, viewed this behavior as being disrespectful towards faculty members. Faculty, on the other hand, recognized the behavior as sometimes being obnoxious, but never interpreted it as being disrespectful towards themselves. Our concern was that if we were being perceived as accepting of this "disrespectful" behavior from some students, other students would view us as being powerless to make real changes to the climate of our department.

6 Impetus for change

At Bryn Mawr, the survey results have helped us to modify our new and evolving computer science program to better address the gender differences we discovered. In creating our curriculum, we are considering the number of required courses for a major, the incorporation of "humanizing" elements in what are considered core computer science courses, the deliberate introduction of problems and examples from diverse disciplines outside of computer science, as well as offering several new courses with a computer science orientation in the freshman writing seminar program. The focus is on attracting more female students to computer science, as majors or minors. We are also attempting to provide entry for non-computer science majors into specially designed upper-level computer science elective courses. See [4] for more details on these.

At Swarthmore, the survey results led us to implement a number of changes: setting ground rules for classroom participation, instituting a new set of lab rules, introducing extreme programming[3] practices in introductory courses to promote interaction among students, creating a women's support group of faculty and students, and starting a mentoring program where upperclass women in CS act as big sisters to freshmen female students. We will discuss each of these in more detail below.

On the open-ended portion of the surveys, both male and female students complained that certain individuals would often dominate classroom discussion, making it difficult for other students to participate. Some students felt intimidated by these aggressive students, who tended to jump in and answer another student's question before the professor could respond. To change these dynamics, some faculty instituted a set of rules for classroom participation: (1) Students should raise their hands and wait to be called on; (2) Students should listen to and respect other students' opinions; (3) Students should refrain from side conversations during class; (4) Students should be willing to table a discussion when the instructor decides it is time to move on to another

topic.

After presenting these rules to an upper-level course, a number of students told us they appreciated this new structure. It remains to be seen whether these rules will have a permanent effect on the classroom dynamics.

We also heard numerous complaints about problematic behavior in the departmental labs at night, when faculty were not present. We instituted a set of lab rules, and the faculty discussed these new rules in their classes. In addition, the rules were prominently posted in the departmental labs. Here is the short version of the rules: (1) Be respectful of others; (2) Use an indoor voice; (3) Bring headphones to listen to music; (4) Anyone may turn on the lights; (5) CS work gets priority on the computers; (6) Please notify the faculty of violations.

In some sense, both the lab rules and the classroom participation rules are common sense courtesy that we should not have to explicitly state. In addition, we had been reluctant to impose rules on lab behavior because, initially, we had wanted to give students the freedom to define the culture in the lab. However, the survey results clearly showed that there was a problem with some students behaving disrespectfully towards other students, and many students stated that they wanted us to step in and do something about it. Consequently, we found that it was necessary to explicitly state and post our departmental rules for classroom and lab behavior.

The survey also revealed that students wished they had more chances to meet their fellow students. A number of students said that they still did not know the names of some of their classmates with whom they had shared several classes. Some research suggests that promoting interaction among classmates promotes retention of female students [5]. To create more classroom interaction, we are now emphasizing the extreme programming principle of pair programming in our CS1, CS2, and CS3 courses [7]. In pair programming, students always work with a partner at a single computer; they must interact in order to solve the problem. Students switch partners each week during in-class exercises so that by the end of the semester they have worked with all of the other students in the class.

In order to provide our female students with a forum for discussing the issues raised by the surveys, we created a *Women in CS* group of female CS faculty and students. We meet monthly for lunch, sometimes with a designated topic, such has how to apply to graduate school, and other times just socially. A report from MIT found that encouraging and supporting social forums for female students in CS helps them feel less isolated as a minority in the department[1].

Finally, a number of studies recommend that role models or mentors are key to retaining female CS students [8, 5]. We are just starting to implement this new program; eight upper-class women have volunteered to serve as mentors and have contacted new female students to let them know of this opportunity.

7 Conclusions

If we are to ensure that students are engaged in our discipline, we have to think beyond fulfilling the criteria established by standardized curricular documents. While these documents play an important role in establishing guidelines, they are at best only that: a guideline. Specific institutions have to take into account multitudes of other overriding concerns, some of which may be limited to localized situations and cannot be widely adopted as such.

A process of continually surveying students is vital to the maintenance and evolution of a healthy computer science program. It helps us make adjustments by identifying emerging trends and shifting attitudes. We believe that other institutions would benefit from conducting their own similar surveys.

References

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