# A Case Study of Retention Practices at the University of Illinois at Urbana-Champaign

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## ABSTRACT

Computer science is seeing a decline in enrollment at all levels of education. One key strategy for reversing this decline is to improve methods of student retention. This paper, based on a 10-month case study at the Department of Computer Science at the University of Illinois at Urbana-Champaign, examines two aspects of student retention at both the graduate and undergraduate levels: community identity and community relationships. Our data shows that students feel isolated from each other, faculty, and members of the greater computer science community. Given our findings, we highlight existing programs and propose new programs which improve student-community interactions. While the lessons learned might not apply at every institution, they constitute a valuable case study for improving conditions for students at large research universities.

## Categories and Subject Descriptors

K.3.2 [**Computers and Education**]: Computer and Information Science Education—*computer science education*

## General Terms

Management

## Keywords

undergraduate, graduate, retention, advising, mentoring, diversity

## 1. INTRODUCTION

Computer science, a field which encourages fun creative problem-solving for great pay, ought to attract many. It should attract those who want to improve web interfaces for the blind, speed up parallel performance for biological simulations, perform search on video content, or create digital narrative media. It should attract those who want to make social impact as others have made world-wide with the cellular phone, Google, and YouTube. It *should* attract and retain all kinds. It *should*, but it does not.

Instead, the faces of today's computer science community do not reflect those of the larger global community. A recent cross-national study of computer science [3] demonstrated male overrepresentation in the field across 16 countries. In 2006, of all surveyed doctoral students in mathematics and engineering, African Americans were more than three times less likely than whites to publish and had lower completion rates than either white or international students [16]. Moreover, interest in computer science is dropping; incoming freshman indicating computer science as a major declined by 70 percent between 2000 and 2005 [12]. Ph.D. interest in computer science in 2006 was half what it was in 2000 [6].

The decrease in enrollment and lack of diversity in computer science suggests that the students who do enroll in computer science need to be encouraged to stay. To determine the best ways to increase retention rates, we asked the students themselves. We conducted a 10-month study at the University of Illinois at Urbana-Champaign (UIUC). We interviewed and surveyed undergraduate and graduate students to get their perspective on issues including mentoring, career plans, teaching, diversity, and work-life balance. This article highlights just two issues that we uncovered.

- **Community Identity**. Students do not see themselves as belonging to the computer science community; there is a gap between the perception of computer scientists and the reality of computer scientists.
- **Community Relationships**. Existing computer science majors require improved mentoring relationships and networking contacts to feel happy about their education and reach their academic goals.

Despite studying computer science in a department of over 700 undergraduates and almost 400 graduate students, our data showed that students feel isolated both from each other and from the senior members of the department and greater computer science community. We highlight existing programs and introduce new ones which educators can use to improve student-community interactions. Our complete study results [7] on recruitment, preparation, and retention are available in a 37 page technical report at:

http://www.cs.uiuc.edu/research/techreports.php


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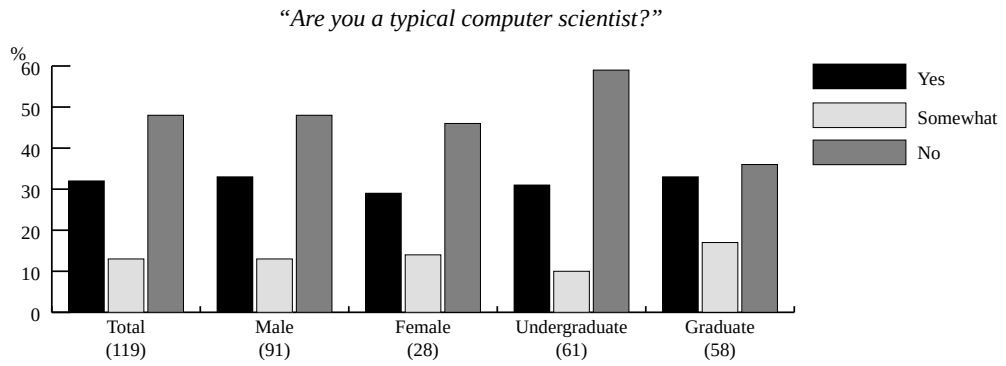


**Figure 1: Participants were asked if they considered themselves a "typical computer scientist." The results were consistent across multiple categories (gender, rank), with about half reporting, "No."**

# 2. CASE STUDY RESULTS

## 2.1 Methodology

We conducted our two-phase study of undergraduate and graduate students during Spring 2006 at the Department of Computer Science at the UIUC under Institutional Review Board project 06290. The student population at the time of the study is summarized in Figure 2. Attrition numbers are maintained by the College of Engineering which recorded a college-wide freshman retention rate of 89.7%. Due to low numbers of underrepresented racial groups in the department, we realized we could not get sufficient data to make any analyses for these groups. We investigated gender differences in our data, but our results demonstrated issues across gender and student rank.

| | Total Students | Female | African-American | Latino/a | International |
|---|---|---|---|---|---|
| Undergraduate | 734 | 9% | 1.5% | 3.8% | 10.4% |
| Graduate | 386 | 14.8% | 0.5% | 1.3% | 45.3% |

**Figure 2: The demographical make-up of the department in Spring 2006.**

Readers concerned about our focus on graduates ought to consider that while these students have "opted in" by completing an undergraduate degree, they often pursue their graduate degree at a different institution with a different climate, student body, faculty, and research emphasis. They may not necessarily be a part of their new institution's community as they were their undergraduate one. We do not wish to merge the problems at the undergraduate and graduate levels into a single problem of retention [10].

In our pilot study, we interviewed four undergraduates and seven graduate students. Study participants were handpicked for a breadth of experiences. The second phase consisted of an on-line survey developed as a result of the pilot, supplemented with interviews. Both survey and interview participants were solicited randomly through departmental e-mail. Female participants were oversampled by announcing the survey to female-only groups one week early. A total of 119 students participated in the survey, with 61 undergraduates and 58 graduates. The survey participants were 24% female and 76% male. We interviewed nine survey volunteers to supplement our quantitative data with qualitative comments, resulting in a total of 20 interviews. Participants received a gift certificate to a local coffee shop.

All figures which appear throughout this paper are taken from the data obtained through in the on-line survey data from the second phase of the study. Quotations from the interviews are used to exemplify the themes of our results.

## 2.2 Community Identity

Computer science departments, like any organized group, have a strong sense of membership and identity. In order to determine how students viewed the departmental culture, we asked participants if they considered themselves a "typical computer scientist" without offering any definition. This gave us insight into participants' own definitions and how they compared themselves to that definition.

About half of the participants did not feel they were a typical computer scientist, as seen in Figure 1. Participants reasons were varied, citing research interests, the number of computer languages they know, their race, their gender, their looks and hygiene, their membership in a fraternity, and other lifestyle elements as reasons why they felt atypical:

*No. I've noticed a lot of the people in the major don't look like me and I'm not particularly enjoying the major at that.*

*No, because I do not enjoy the low level intricacies of computer systems. I am more interested in building computer tools that have a direct impact on human life and for whatever reason, that isn't considered as pure computer science.*

*No. I think we theoreticians are far too 'math' to be typical.*

*No. I'm more of a jack of all trades. I like computer science, but my life doesn't completely revolve around it. I write; I read; I make music; I cook.*

Part of what may contribute to this identity problem is a lack of interaction between students and faculty. Using an open-ended question, we surveyed students' ideas to improve the department. Of graduate participants, 31% cited increasing student-professor interactions; 24% of undergraduates suggested more faculty interaction and social activities. One graduate student wrote,

*One of the things that surprised me when I got here was how little interaction there is among students, especially across research groups. . . . I think I would have benefited a lot from seeing the kinds of projects other students were working on, and talking to them about how to go about getting started with my own research.*

## 2.3 Community Relationships

Two groups which can strengthen a student's membership in the community are advisors and mentors. Advisors can help select a career in which students can be productive, or help make progress on research. Mentoring gives students access to other senior members of the community who can give advice and support; it is also a positive predictor for degree completion in graduate students [16].

### 2.3.1 Advising

Undergraduates are assigned a faculty advisor upon entering the program. Most undergraduates interviewed did not meet with their advisor, but instead relied on peer advising. One participant reported that she didn't feel she had anything to discuss with her advisor; he didn't know enough about the classes to get help with course planning. A single undergraduate participant interviewed reported a positive interaction with her advisor; this participant was also the only undergraduate with any research experience.

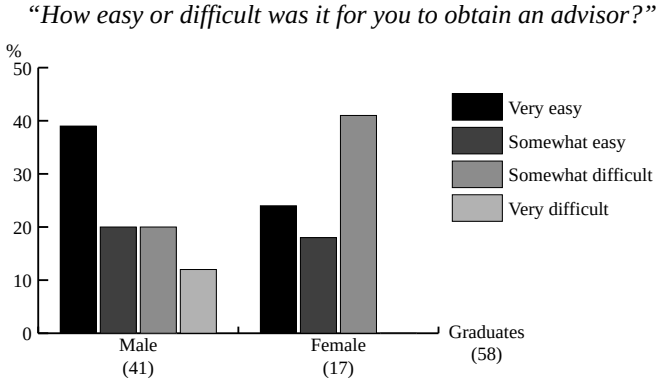


**Figure 3: Graduate participants were asked to rate the ease or difficulty with which they obtained an advisor. No female participant reported that it was "very difficult" to obtain an advisor.**

For graduate students, an advisor plays quite a different role. Graduate students must seek out their own research advisors by their third semester and work with them to the end of their degree. Obtaining an advisor can be a challenge, as reflected in Figure 3. Finding an advisor appeared to be more difficult for women; 39% of males versus 24% of females reported having a "very easy" time obtaining an advisor.

During the interviews, many graduate participants echoed the feeling that "there are more students than there are advisors." One participant said that she spoke to "five or six professors before getting an advisor." Another participant reported she was delaying the qualification exam to her fifth semester because she still did not have an advisor. She said, "Professors are not helpful with students gaining a background to be in a particular area of research." She also reported that when she came to UIUC, she expected she could "do any research I wanted" and didn't expect the research opportunities to "be so narrow." A male student said,

*I wish someone had told me what I should be looking for in an advisor, what I should be expected to do right away, what the available research areas are, the delicate balance of taking classes and doing research, and the funding problems in the department.*

### 2.3.2 Mentoring

Not all students feel that they need mentors; approximately 52% of undergraduate participants and 26% of graduate participants who did not have a mentor would like to have one. During the interviews, we captured some of the attitudes of those participants without mentors. One participant with an advisor said she felt a mentor would be very valuable, but felt uncomfortable seeking out a mentor. She said, "If I had to pick one tomorrow, I know who it would be" but couldn't bring herself to do it. She said, "There is no formal system, which is unfortunate" and suggested the value of a formal system in which students could opt for a mentor. Another participant without an advisor or mentor said, "I did not expect the lack of mentorship" that she found at UIUC and felt that,

*The last thing the faculty cares about is chatting about my problems. No one would be interested in mentoring me. People here just care about great research, not about mentoring.*

Other students reported having mentors: approximately 18% of undergraduates and 53% graduates reported having a mentor. Figure 4 summarizes the sources. For the undergraduates, faculty members and students were relied upon most. The Women in Computer Science (WCS) group appeared to be a major source for peer mentors. Interviews revealed WCS as an effective social support group for some subset of the female and even male population of undergraduate students. However, other students mentioned having a more diverse set of interests than WCS could address.

*Most people in it are all very . . . into video games and anime, and so I really don't feel like I feel I fit in. When I did try to sophomore year, and I found out that guys are in it . . . Dude, I deal with enough guys already. Where do the women come in?*

While this interviewee expressed a need for a space where she can escape the "guys" that she encounters on a daily basis, other women involved in WCS appreciate the support of the men in the department and welcome them into the group. Balancing single and mixed gender groups is difficult, but research shows that doing so is necessary to support women as an underrepresented group while allowing men to actively create a climate more open to diversity [4].

The top source for graduate student mentors was the advisor. However, only 49% of graduate students with an advisor reported that their advisor was their mentor. Graduate students did not regard their advisors as mentors for various reasons. Many participants expressed a reluctance to speak with their advisor regarding personal or even non research-related issues. One female participant with a male advisor said, "There are things I wish I could talk to my advisor about," though she could talk to a female advisor about the same issues. Other participants reported a disconnect between their idea of a mentor and their own advisor. One male participant said of his advisor,

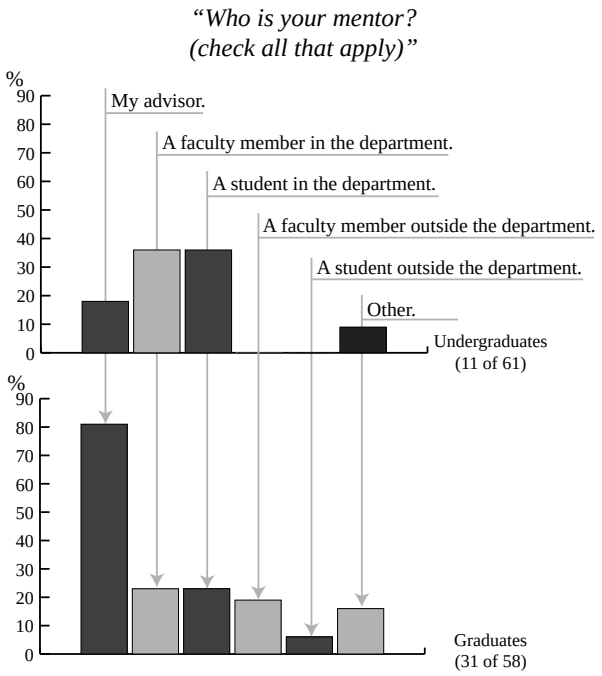


**Figure 4: Those participants who reported having a mentor were asked to report on the source of their mentor. "Other" sources of mentors included those found on programs such as MentorNet, past employers, or family members.**

*It's not like she's 60 with lots of experiences. When I think of a mentor, I think of some old guy who can pull strings for you to get a job.*

Another participant with a male advisor echoed this perception, and defined his would-be mentor as, "Someone who is on my side who has some influence." Another participant cited her advisor's lack of networking help,

*I guess that the typical thing that I see is when you go to a conference and you take your student and you start introducing your student to everyone, and that has never happened [to me]...That one conference that I went to, he wasn't there. I listened to people's talks, but I couldn't make any connections.*

# 3. RECOMMENDATIONS

We highlighted three areas which students commented on in our study. Here we suggest existing solutions to the challenges presented. The notable theme among these solutions emphasizes relationships between varying members of the community.

## 3.1 Community Identity

**Increase community interactions**. About half of the students surveyed did not consider themselves a "typical computer scientist." Increased interaction between students and faculty can help members find others with whom they identify. **!bang** is a computer science organization whose goal is to foster more social activities at UIUC. They host 2-4 events per year, sponsored by ACM and WCS. In recent years, **!bang** has hosted the bi-annual **!casino** event. Professors volunteered as dealers for blackjack, poker, and roulette tables, providing informal interactions between professors and students. Many students felt this was an excellent chance to meet professors and other students, and indicated a desire for more events like this.

Similarly, the CS department at UIUC began hosting weekly brown bag lunches for the graduate students every Friday. Faculty take turns hosting and provide a topic for discussion in order to informally interact with the graduate students. The reaction from students we interviewed encouraged the department to continue these lunches and provide pizza to encourage further attendance.

## 3.2 Community Relationships

**Increase early research opportunities.** Given that an important indicator of success in the department is research, it is very important that graduate students have many opportunities to find an advisor and begin research early. A good example of this type of opportunity exists very near to the Computer Science Department. Since June 2000, UIUC's Department of Mathematics has participated in the NSF Vertical Integration of Research and Education in the Mathematical Sciences program. VIGRE provides for a number of work groups which fostered interaction among undergraduates, graduates, postdoc and faculty. Despite the program completion in 2005, VIGRE groups continue to meet, marking the success of the program.

**Create multiple and diverse mentoring programs.** The current doctoral education at UIUC relies on a student's advisor to be his mentor. Yet, only 49% of graduate students with an advisor regarded their advisor as their mentor. Realistically, no advisor can be the perfect mentor to all her students; we suggest providing multiple and diverse options for graduate student mentors. The University of Southern California's Department of Mathematics assigns mentoring triplets at the beginning of the academic year. Triplets consist of a first-year graduate student, an advanced graduate student, and a faculty member.

**Harness existing social networks to advertise mentoring programs.** Of the participants, 60% undergraduates and 80% graduates were unaware of any mentoring programs in UIUC's Department of Computer Science, even though such opportunities do exist. For example, the graduate student organization recently developed a new mentoring program for first year graduate students. Since many of today's students use social networking programs such as Facebook to meet new people and network, the mentoring program members also created a complement group on Facebook called "UIUC CS Grad Mentors". Similarly, WCS has begun recruiting new students into their mentoring program as early as the first week of school by hosting a welcoming dinner for all freshman.

# 4. RELATED WORK

Much research on the decreasing enrollment in computer science education focuses on two potential "solution" areas: recruitment and retention, which involve getting more students to join and to stay [2, 5, 14]. Some recruitment strategies involve outreach efforts which attempt to make computer science look "cool," exciting, useful, and rewarding, but do not involve student attitudes in developing solutions

[8]. Other, more researched strategies often recommend opening up admissions criteria without lowering standards, welcoming reentry students, and providing opportunities to bridge educational gaps between students' previous education and entry-level courses at a university [14].

Retention efforts involve support structures for existing students, particularly those who are underrepresented and are thus more likely to leave. Such support structures can be fostered by providing role models via effective advising and mentoring relationships [2, 9, 17, 13]. For undergraduates, advising helps the student select courses and fulfill requirements; it also frequently determines the level of interest in pursuing career options or even a graduate degree [11]. For graduates, positive advising relationships can help foster self-confidence and research success, as well as result in more productive and happier students [16]. With mentoring, students can reach out to their more experienced colleagues and faculty for support. Mentoring also has an impact on whether students finish a program, get good advice, and feel happy about their education [16].

New research areas for solving the problem of decreasing enrollment work to create a flexible culture of computing which is open to diversity and allows students and faculty to define for themselves what is means to be a computer scientist [2, 14]. New strategies acknowledge that the path to a computer science major is not linear [21]; others use concepts such as pair programming [15, 20], undergraduate research experiences [18, 19], or meaningful group projects [1] which focus on engaging and socializing students in the mainstream curriculum rather than helping them to simply cope with an unfriendly environment. Our work [7] complements these new strategies. We uncover student attitudes about existing mentoring and advising programs at the University of Illinois at Urbana-Champaign to determine how to foster this flexible culture.

## 5. CONCLUSION

Based on our case study of UIUC, we proposed a set of recommendations to increase retention in computer science, paying special attention to introducing newcomers to the community while improving enrollment and diversity. We do not expect that readers identify completely with the challenges uncovered at UIUC. Different workplaces, schools and universities have different strengths and weaknesses. Instead, our hope is that our results will help readers to formulate the right questions to ask their community members and better introduce newcomers.

Our future work includes conducting the survey at multiple institutions to get a nationwide picture of student attitudes on community identity and community relationships. We also want to repeat our survey at UIUC to see if our newly introduced programs such as the weekly lunches and the Facebook mentoring group impact students feelings of isolation in the department.

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