

Recruitment and Retention of Undergraduate Students in Computing: Patterns by Gender and Race/Ethnicity

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Computing Research Association Evaluation

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About CERP

The Computing Research Association's (CRA) Center for Evaluating the Research Pipeline (CERP) evaluates the effectiveness of intervention programs designed to increase retention of individuals from underrepresented groups in computing, namely men from underrepresented racial/ethnic groups, and women of all racial/ethnic backgrounds. More generally, CERP strives to inform the computing community about patterns of entry, subjective experiences, persistence, and success among individuals involved in academic programs and careers related to computing. For more information about CERP, visit http://cra.org/cerp/.



Computing Research Association

CERP

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acknowledgments



Executive Summary

- » Compared to men, women are:
 - less likely to join computing
 - more likely to think about leaving a computing major
 - more likely to actually leave.
- » No significant differences were found among students of different races/ ethnicities (Asian, Under-represented Racial Minorities, White).
- » Given that these data are the first wave of longitudinal data collection, further analysis using follow-up data collected from the same students as well as additional cohorts of students are necessary to verify these trends and examine any casual mechanisms.

What is in this report?

This report presents data on (1) recruitment of new students into a computing major, (2) retention of computing students, (3) computing students' reasons for leaving their major and (4) the majors students pursue when they leave computing. Most of the data presented in this report are broken down by gender and by race/ethnicity.¹ When sample sizes are sufficiently large, chi-square tests are conducted to test the statistical significance of any relationship between measures of interest, and gender and race/ethnicity. The results of these tests are presented in each section.

For the purposes of this report, race/ethnicity is divided into three groups: Asian, underrepresented racial minority (URM, including Black/African American, American Indian/Alaska Native, Arab/Middle Eastern/Persian, Hispanic/Latino), and White. This grouping reflects three primary racial/ethnic groups in computing: Asian and White students, who typically participate in computing at rates higher than their proportions in the general populations, and URM students, who tend to participate at rates at or below their proportion in the general population. Analyses on race/ethnicity are run separately from analysis on gender. Thus, each racial group contains both women and men, and each gender group contains all three racial/ethnic groups.

Findings should be interpreted with caution due to small samples sizes, and potential selection bias in who responded to our surveys. For instance, given that our surveys' primary focus is on experiences in computing, students who have left computing may have felt less compelled to complete our surveys than students who continue to be engaged in computing. Furthermore, students who have left computing and opted to complete our surveys may be those who are particularly dissatisfied with their computing experience, and wish to voice dissatisfaction with the computing major.

¹ An exception to this is (3) students' reasons for leaving their major, because data for this topic are qualitative.

Where do the data come from?

CERP conducts a national annual survey of undergraduate students affiliated with computing (i.e., major, minor, enrolled in computing courses). In 2014, we asked students for their permission to follow-up with them in 2015. Using students' contact information to match responses across the two surveys, we were able to create a longitudinal dataset.

The survey asks students a variety of questions including:

- current major
- thoughts about leaving their major
- reasons for changing to a non-computing major
- demographic information including gender and race/ethnicity

In 2014, we asked students for their permission to followup with them in 2015.

Who is in the sample?

There were 4,061 undergraduate students who responded to CERP's survey in 2014. Of those students, 2,915 (72%) agreed to be contacted for follow-up; when we contacted these students in 2015, 1,026 (35%) completed our follow up survey. Among students who responded to the follow up survey, 943 (92%) were in a computing major, 77 (7%) were in a non-computing major, and 6 (1%) were undecided in 2014. In 2015, while 902 (96%) of the students in a computing major in 2014 were still in a computing major, 40 (4%) left computing for another major or changed to an undeclared major. Figure 1 visualizes this information.

Figure 1. Sample

Follow-up consent and response rate



respondent did not report his/her major for 2015.

Recruitment into computing: Who joins?

Students' majors in 2014 and 2015 were coded using the following categories: computing major, non-computing major, undeclared.²

Using this coding scheme, we first looked at the 83 students who were in a non-computing major (n=77) or had not declared a major (n=6) in 2014. Each of these students reported their major status in 2015 when they responded to our follow-up survey.

- Among non-computing majors in 2014, women were less likely to become computing majors in 2015 compared to men, X^2 (1, N = 82) = 9.41,p < .01.
- White students, who were non-majors in 2014, joined a computing major in 2015 at a higher rate than both Asian and URM students. However, this difference observed in percentages was not statisitically significant, X^2 (2, N = 79) = 1.14, $p = .57.^3$



Figure 2. Recruitment

Note. Sample sizes in this figure do not add up to our full sample (N = 83) because one student did not report their gender, and four students did not report their race/ethnicity.

3 This statistic represents the omnibus Chi Square test for the 3 (Race/ethnicity: Asian, URM, White) x 2 (Major: computing, noncomputing) model. Throughout the report, no differences were found between pairs of race/ethnicity categories; statistics for race/ethnicity pairwise comparisons are therefore not reported.

² In 2014, students were asked to identify their major in one of the following four categories: computing major, computing minor, neither a computing major not a minor, and undecided. Students were prompted with our definition of "the field of computing", which is the following: computer science, computer engineering or electrical and computer engineering, computing information systems, or other computing-related field including interdisciplinary fields with a strong computing component such as computational biology or digital media. In 2015, students were asked to identify their major from a list of majors. We used the same categories used in 2014 to code each student in terms of whether they were in a computing major. Students who were not in a computing major received our survey because they were taking classes in computing or were otherwise associated with computing. In other words, these are students who have some contact with computing and could potentially pick it as their major.

Retention in computing: Who leaves? Who stays?

We next looked at students who were in a computing major in 2014 ($N = 942^4$), the rate at which students left their computing major, and whether students left their computing major at differential rates based on their gender or racial/ethnic identity. We found students were very unlikely to leave, but when they did, there appeared to be a gender disparity.

- Women were more likely than men to leave computing, X^2 (1, N = 931) = 4.10, p < .05.
- The tendency to leave computing did not differ among racial/ethnic groups at the .05 significance level, X^2 (2, N = 884) = 5.46, p = .07. Since the p-value is relatively small, we conducted additional comparisons of pairs of the three racial/ethnic groups and found that URM students were more likely to leave their computing major than White students, z = 2.17, p < .05.



Figure 3. Retention

Note. Sample sizes in this figure do not add up to our full sample (N = 942) because 11 students did not report their gender and 58 students did not report their race/ethnicity.

⁴ There were 943 computing majors in 2014. One respondent did not report his/her major for 2015.

Thoughts about leaving a computing major

Among students who were computing majors both in 2014 and 2015 (N= 902), 20% told us they had considered leaving their major since declaring. We found gender differences in this tendency, but no race/ethnicity differences.

- Women were more likely to have thought about leaving their major than men, X^2 (1, N = 862) = 7.56, p < .01.
- Although, based on percentages, a larger share of Asian and URM students thought about leaving their major, these differences were not statistically significant, X^2 (2, N = 819) = 3.15, p = .21.



Figure 3. Thinking of leaving a computing major

Note. Sample sizes in this figure do not add up to our full sample (N = 902) because 31 students did not report whether they thought about leaving their computing major. 9 students did report their gender, and 52 students did not report race/ ethnicity.

Why do students leave their computing major?

The students who left their computing major were asked to explain why they decided to leave. These data were collected through free-text entry. Students' responses were coded, and two major themes emerged: environmental challenges and loss of interest.

• Forty-three percent of students said they changed to a non-computing major because of the challenges they faced, which ranged from difficulty of coursework to an unwelcoming environment in the computing major. Approximately half of these students indicated that their reason for leaving was mainly difficulty of coursework while the other half stated that they did not feel welcome in the community/classes. Sample excerpts for this theme include the following:

It became too difficult for me to maintain good grades.

The environment was harsh and un-motivating.

• Thirty-eight percent of students said they changed to a non-computing major because they had lost interest in computing, or were interested in something else. Two excerpts for this theme follow:

[I] did not have passion to study and work in computing. [I] would rather focus on more fulfilling work with environmental conservation.

I did not enjoy the material. I was miserable while doing coursework.

Where do the students who leave their computing major go?

We asked students who left their computing major to identify the new major they selected in 2015. We then categorized these majors into six broad fields: business/finance, humanities/arts, social sciences, engineering, math/statistics, and physical sciences. In looking at the majors broken down by gender and race/ethnicity, some interesting patterns emerged. Note these results should be interpreted with caution, because patterns may be unreliable due to small sample sizes.

- A greater percentage of men opted into other technical fields, such as engineering, math/ statistics, and physical sciences than women. A greater percentage of women opted into the humanities/arts and social sciences than of men.⁵
- Among different race/ethnic groups, a larger percentage of Asian students opted into engineering, math/statistics, and physical sciences than their peers.



Figure 4. Majors students move to after they leave computing

Note. Sample sizes in this figure do not add up to our full sample (N = 40) because 2 students did not report their gender, and 4 students did not report their race/ethnicity.

⁵ Small sample sizes do not allow for inferential statistics on these trends

Summary and Future Directions

Longitudinal data from one cohort of students indicate that, compared to men, women are less likely to join computing, more likely to think about leaving a computing major, and more likely to actually leave. None of the recruitment and retention measures presented here showed significant differences between Asian, URM, and White students.

This report provides a glimpse into recruitment and retention patterns in computing at the undergraduate level. While the longitudinal data presented here allow us to track students' major decisions over time, it is important to note that small sample sizes and/or potential selection biases (e.g., longitudinal data may be more difficult to obtain for students who leave computing than students to persist in computing) require caution when interpreting these results.

CERP is currently collecting the same longitudinal data reported on here from a second cohort of students, as well as a third wave of data from the cohort of students in the current report. As such, future iterations of this report will aim to replicate the analyses reported here using larger datasets aggregated across multiple cohorts, as well as datasets spanning a longer time period.







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