University of California, San Diego Computer Science and Engineering Early Scholars Research Program: Cohort 1 Follow-Up Evaluation Report

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Evaluation

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CRA-W
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Women

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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/.

Executive Summary

Compared to a group of students who had not completed a formal research experience, UCSD ERSP students:

- Were more likely to have a mentor
- Reported their mentor was more supportive
- Were more confident in their ability to get admitted to graduate school
- Were more intent on pursuing a graduate degree
- Were more interested in pursuing a computing career at the professorate level, and at the high school level

Introduction

The Computer Science and Engineering (CSE) Early Research Scholars Program (ERSP) at the University of California, San Diego (UCSD) seeks to provide students early in their computing major with (1) a sense of community and support from peer groups and both near-peer and faculty mentors, (2) practical skills that will help them succeed both in their undergraduate program and beyond (3) the confidence that comes from knowing they have the skills to contribute to problem solving beyond the classroom, and (4) motivation, inspiration and challenge through exposure to real-world research problems in computer science.

This report focuses on the first cohort (Cohort 1) of the ERSP, who began participating in the program during the spring of 2014. During the fall of 2015, Cohort 1 was surveyed on their experiences in their department and in the computing community more generally, and their aspirations for the future. Cohort 1's experiences and aspirations were compared to those of a sample of students outside of UCSD who had not participated in a formal research experience during the prior academic year. As will be seen, the non-ERSP comparison group was extracted from a larger sample of students, and matched to Cohort 1 students on a number of demographic variables so that the primary difference between student groups was whether or not they had participated in the ERSP.

Method

Procedure

During the fall of 2015, CERP distributed a survey to ERSP Cohort 1 participants (n = 17), and a national sample of undergraduate students who were pursuing a major or minor in a computing field[1] at universities across the U.S. (n = 4,649). The survey measured students' subjective experiences in the computing community, and prior experience with formal research. Survey items and scales can be found in Appendix A.

Survey Respondents

To assess the impact of the ERSP program on students' experiences in the computing community and their career aspirations, we utilized a comparative evaluation framework. For this, we culled students who had not completed an undergraduate research experience during the preceding academic school year at their home institution, which was a Ph.D. granting university (n = 2,121), from our larger sample of students who had completed the CERP survey. Among this group of students, we extracted a subsample

[1] We define computing field to be any of the following: computer science, computer engineering or electrical and computer engineering, computing information systems, or other computing-related field including fields with a strong computing component such as computational biology or digital media.

using propensity score matching. Propensity score matching is an analytic technique that "matches" individuals in a treatment group (e.g., Cohort 1 ERSP students) to individuals from a comparison group (e.g., students who had not participated in an REU) who are as comparable as possible on a set of relevant individual-level characteristics [1,2]. Thus, propensity score matching controls for the role of student-level variables (e.g., year in college) that might otherwise explain outcome variables (e.g., self-efficacy) rather than the "treatment". Non-ERSP students were matched to ERSP students on three variables: academic class, gender, race/ethnicity, and major (computing vs. non-computing). See Appendix B for the two samples' demographics.

A Note About the Analyses

The sample sizes for the Cohort 1 group and the non-REU group were small (n = 17 for each group), rendering the reliability our findings potentially unstable. As such, we urge readers to interpret the following analyses with caution. Future evaluation work conducted by CERP for the ERSP will examine data across multiple cohorts of participants, yielding a larger sample size, and more reliable analyses.

Dependent measures were either aggregated across multiple items when reliability was strong, or measured using a single survey item. See Appendix A for aggregate measures' reliability statistics. We compared Cohort 1 vs. Non-REU mean scores for Likert style measures using independent samples t tests. We used Pearson Chi Square tests to compare frequency data (i.e., binary responses) across the two student groups. We used a two-tailed test, with a cut-off alpha criterion of $p \leq .05$, to determine statistical significant for each analysis.

Results

Support and Mentorship

As seen in Table 1, students without an REU were more likely than Cohort 1 students to not have a mentor, $X^2(1, N = 34) = 8.24$, $p < .01$. Cohort 1 students were more likely than Non-REU students to indicate that they had a mentor who was a professor within their department, $X^2(1, N = 34) = 5.85$, $p < .05$, and an individual from a formal mentoring program, $X^2(1, N = 34) = 5.89$, $p < .05$, $p < .05$. Table 2 shows that Cohort 1 reported higher perceived mentor support than students who had not participated in another REU, $t(32) = 2.34$, $p \leq .05$. However, students' reported level of mentor support was below the midpoint of the scale, suggesting room for improvement in students' level of mentor support. Students' level of department support, and peer support within their department did not differ across student groups.

Table 1. Mentorship

Percent reported who among the following they considered to be a mentor:	Cohort 1	Non-REU
A professor within my department	65%	24%*
A professor at my college/university who is outside of my department	29%	18%
An individual I met through a formal mentoring program sponsored by an outside organization	42%	6%*
No one	12%	59%*

* $p \leq .05$; Comparison against Cohort 1.

Table 2. Sense of community and support

Scale anchors ranged from *(1) Low* to *(5) High*	Cohort 1	Non-REU
Departmental support	3.57	3.29
Mentor support	2.82	1.96*
Peer support	3.22	2.82

* $p \leq .05$; Comparison against Cohort 1.
Note. Values indicate mean score across respondents.

Confidence

We assessed students' confidence in a variety of computing-related skills. Among those, we found that Cohort 1 students were more confident than non-REU students in their ability to get admitted into a graduate program in computing, $t(32) = 2.36$, $p < .05$. Cohort 1 students were also more confident in their ability to become leaders in the field of computing, though this effect was marginal. With two exceptions (confidence in winning a computing contest; becoming a leader in computing), students' confidence was above the midpoint of the scale. See Table 3.

Table 3. Confidence

I am confident that I can… *(1) Strongly disagree to (5) Strongly agree*	Cohort 1	Non-REU
Learn a new programming language	3.76	3.94
Clearly communicate technical problems and solutions	3.71	3.59
Win a computing contest	2.59	2.12
Complete undergraduate degree in computing	4.24	4.35
Get admitted to graduate computing program	3.24	2.41*
Find employment in computing	3.76	3.00
Become a leader in computing	2.82	2.18+

* $p \leq .05$; + $p = .08$; Comparison against Cohort 1.
Note. Values indicate mean score across respondents.

Identity, Career Interests, and Aspirations

Student groups did not differ in the degree to which computing was central to their identity, though both groups indicated relatively high identification with computing (i.e., above the midpoint; see Table 4). Cohort 1 students reported stronger interest in pursuing a career in the computing professorate, $t(31) = 2.07$, $p < .05$, and in being a high school computing teacher, $t(32) = 2.19$, $p < .05$, compared to students without an REU. No other group differences in career interests emerged.

Table 4. Identity and Career Interests

Scale anchors ranged from *(1) Low* to *(5) High*	Cohort 1	Non-REU
Computing identity	3.63	3.63
Career Interests		
College/University professor in computing field	3.60	2.19*
Computing researcher in industry/government	3.18	3.00
High school computing teacher	2.65	1.82*
A non-research position in computing industry	3.81	3.88
Position applying computing research to another area	3.76	3.76
Non-research position applying computing to another area	3.76	3.71
Entrepreneur (computing related)	3.59	2.88
Non-computing career	2.71	2.53

*$p \leq .05$; Comparison against Cohort 1.
Note. Values indicate mean score across respondents.

As seen in Table 5, both groups of students' highest degree plans were primarily in computing. However, Cohort 1 students were more likely than Non-REU students to indicate degree intentions at the graduate level, $X^2(1, N = 34) = 6.10$, $p < .05$.

Table 5. Aspirations

	Cohort 1	Non-REU
Plan to attend graduate school	59%	18%*
Plan for highest degree to be in a computing field	88%	82%

* $p \leq .05$; Comparison against Cohort 1.
Note. Values represent percentage within each group.

Summary and Conclusions

This follow-up analysis finds that, relative to students without an REU, the first cohort of ERSP students was more likely to have a mentor, reported their mentor was more supportive, was more confident in their ability to get admitted to graduate school, was more intent on pursuing a graduate degree, and was more interested in pursuing a computing career at the professorate level, and at the high school level. Thus, the ERSP appears to be meeting its goals to provide a sense of support from mentors, build confidence in students' ability to continue to be successful in computing (i.e., continue their training via postsecondary work), and inspire students to pursue graduate training and become future computing researchers and educators.

On the other hand, Cohort 1 ERSP students did not report stronger departmental or peer support, compared to students with no REU. This is surprising, given the intentionally supportive and close-knit nature of the ERSP. It is possible that while the ERSP provides a supportive environment, the larger UCSD computing department is relatively less supportive, resulting in ERSP and non-REU students reporting the same level of department and peer support. Furthermore, we did not find that ERSP students were more confident than Non-REU students on technical computing ability (see Table 3). If technical skills fall under the umbrella of the ERSP's goal to provide practical skills that will help them succeed both in their undergraduate program and beyond, future iterations of the ERSP might focus more heavily on this type of training.

A particularly strong point of the program appears to be that it drives students to pursue graduate work in computing. Given the ERSP's success in recruiting underrepresented students in computing, the ERSP appears to be a promising program that can help foster diversity in computing careers – particularly in the professorate, and among high school educators.

References

1. Bai, H. (2015). Current issues on propensity score matching: Matching with/without replacement, common support, and sample ratio. In W. Pan, & H. Bai (Eds.), *Propensity score analysis: Fundamentals, developments and extensions.* New York, NY: Guilford Press.

2. Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference.* Boston: Houghton Mifflin.

Appendix A

Our measures included single survey items as well as constructs that combine multiple survey items into a single measure. We determined reliability for multi-item constructs using Cronbach's alpha (α). Alpha levels ≥ .70 are considered acceptable. Below are all the survey items used in this report.

1. Sense of Community and Support

Mentorship

Who do you consider to be a mentor? Select all that apply.

- A professor within my department
- A professor at my college/university who is outside of my department
- An individual I met through a formal mentoring program sponsored by an outside organization
- No one

Departmental support, α = 0.87

Rate how you feel about the environment of the department of your computing program.

- I feel a sense of community in my department.
- My department cares about its students.
- The environment in my department inspires me to do the best job that I can.

Strongly Disagree (1)	Somewhat Disagree (2)	Neither Agree nor Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)

Mentor support, α = 0.89

To what extent do you have a mentor who....

- helps you improve your computing skills.
- shows compassion for concerns and feelings you discussed with them.
- shares personal experiences as an alternative perspective to your problems.
- explores career options with you.

Not at All (1)	A Little (2)	Somewhat (3)	Quite a Bit (4)	Very much (5)

Peer support, α = 0.94

How often is each of the following kinds of support available to you from other students in your computing program if you need it?

- Someone to hang out with.
- Someone to confide in or talk to about your problems.
- Someone to get class assignments for you if you were sick.
- Someone to help you understand difficult homework problems.

Strongly Disagree (1)	Somewhat Disagree (2)	Neither Agree nor Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)

2. Confidence

How much do you agree or disagree with the following statements? I am confident that I can...

- quickly learn a new programming language on your own
- clearly communicate technical problems and solutions to a range of audiences
- win a computing-related contest (e.g., programming contest, robotics contest, hackathon)
- complete my undergraduate degree in computing
- get admitted to a graduate computing program
- find employment in my area of computing interest
- become a leader in the field of computing

Strongly Disagree (1)	Somewhat Disagree (2)	Neither Agree nor Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)

3. Identity, Career Interests, and Aspirations

Identity, α = 0.85

How much do you agree or disagree with the following statements?

- I feel like I belong in computing
- Computing is a big part of who I am
- I see myself as a computing person
- I care about doing well in computing

Strongly Disagree (1)	Somewhat Disagree (2)	Neither Agree nor Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)

Career Interests

How interested are you in having the types of jobs listed below after you finish your highest degree?

- College/University professor in computing field
- Computing researcher in industry or government lab
- High school computing teacher
- A non-research position in the computing industry
- Position applying computing research to another area (e.g., digital media, support of research in medicine or other sciences)
- Non-research position applying your computing knowledge in another area (e.g., business applications, government)
- Entrepreneur (computing related)
- Non-computing career

Very Disinterested (1)	Somewhat Disinterested (2)	Neither Disinterested nor Interested (3)	Somewhat Interested (4)	Very Interested (5)

Highest degree intention

A student was coded as planning to pursue a graduate degree if they selected either Master's or Doctoral degree.

What is the highest degree you plan to attain?

- Associate's degree
- Bachelor's degree
- Master's degree
- Doctoral degree
- Professional degree (MD, JD, DDS, Ed.D, etc)
- Uncertain
- Other, please specify ____________________

Plan for highest degree to be in a computing field

A student was coded as planning for highest degree to be in a computing field if any of the following were selected.

In which field do you plan to attain that degree? Please select all that apply.

- Computer Science
- Computer Engineering or Electrical and Computer Engineering
- Computing Information Systems or Information Systems
- Other computing major

Plan for highest degree to be in a computing field

A student was coded as planning for highest degree to not be in a computing field if any of the following were selected.

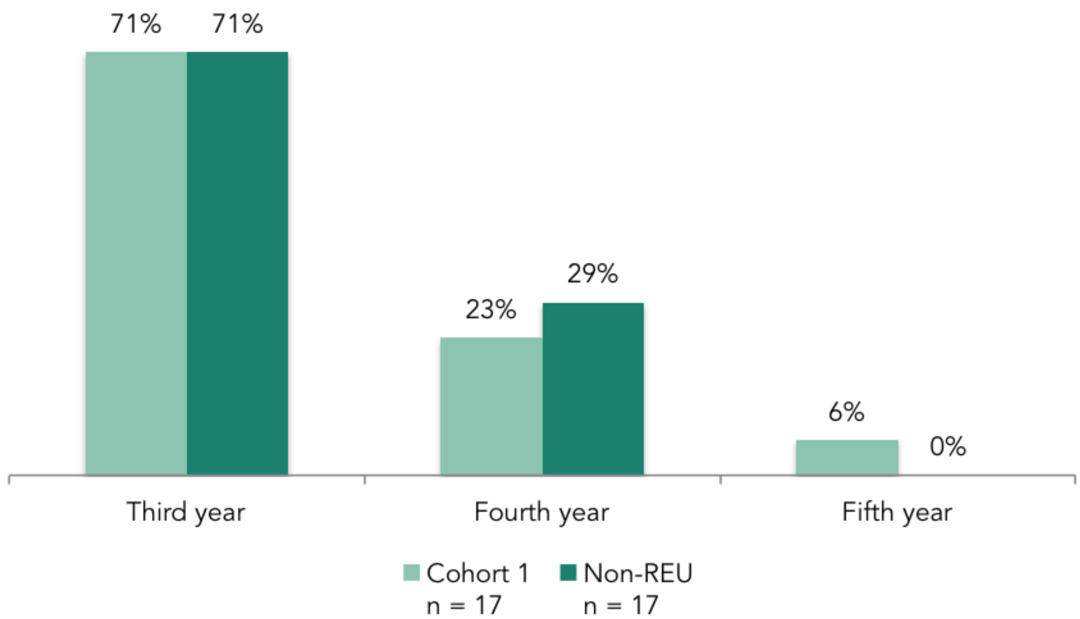
In which field do you plan to attain that degree? Please select all that apply.

- Math/Applied Math
- Business or Law
- Life/Health Sciences
- Interdisciplinary, please specify areas ____________________
- Other science or engineering non-computing major; please specify___
- Uncertain
- Other non-computing major; please specify ____________________

Appendix B

Distributions of academic status, gender x race, and major for Cohort 1 versus Non-REU students.

Figure 1. Academic Status by Student Group



Note. Minority = Black/African American, Hispanic/Latina/o, Native American, Native Hawaiian/Pacific Islander, Arab/Middle Eastern/Persian, and students of more than one race that included any of the minority racial groups listed here.

Figure 2. Gender x Race by Student Group

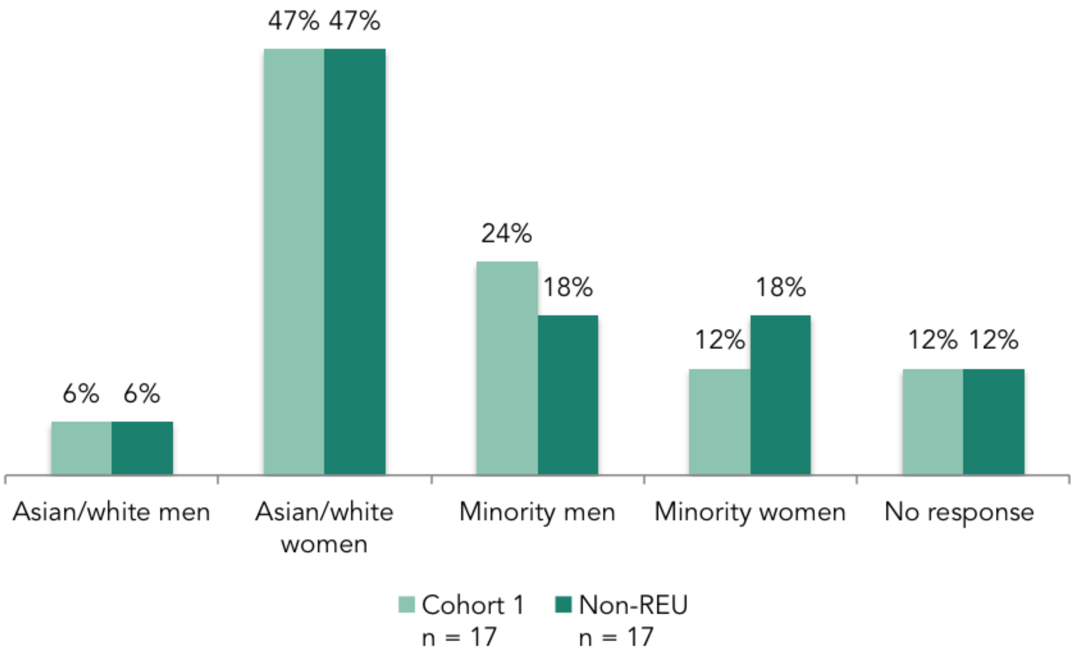


Figure 3. Major by Student Group