AT HOME WITH ENGINEERING EDUCATION

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Student Sense of Community Through an Introductory Computer Programming Course Sequence

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Motivation

- Large research university
- Large intro computer programming courses (~700-800 students/semester… and rising!)
- Previous studies (ASEE 2018, 2019) showed minimal significant differences between men and women on a single measure of inclusion, and no significant differences between underrepresented minority students and non-underrepresented minority students

Motivation

- Those previous studies used a single survey question to assess inclusion:

  > "I believe that other students in computer programming courses will be welcoming of me"

- We wanted to look at a more nuanced picture of student inclusion as they progress through a CS1 → CS2 → CS3 introductory programming sequence.
- Specifically, we wanted to look at how students' sense of community changes as they go through these large courses.

Some Quick Category Definitions

As stated in the paper:

- To classify students as URM vs. non-URM, we started with the definition used by our institution, which in turn relies on the NSF definition of URM students.
- Our institution defines URM students as persons that identify as African-American/Black, Hispanic, and Native American.
- In our analysis, we categorized all students who identified as solely "White" or solely "Asian" as non-URM students and all other students as URM students.
- We classified students as women, men, or non-cisgender. We started with the students' self-reported gender on the surveys.
- In our analysis, we categorized students who selected "Woman" as women, students who selected "Man" as men, and all other students as non-cisgender.

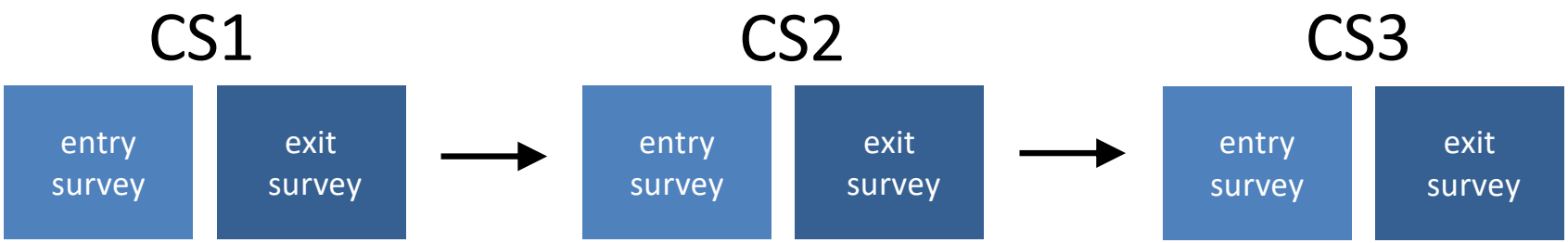
Research Question and Hypothesis

Research Question: How do students' sense of community change over time through an introductory computer programming sequence?

Hypothesis: Women and under-represented minority students feel less a part of the community, as compared to men, at the start of CS1, but they feel more a part of the community by the end of CS3 than they do at the start of CS1.

Methods

Students were offered credit to complete exit and entry surveys for each of the three classes in the sequence.



The surveys were designed to be parallel to allow for direct comparison of students' ratings from one moment in time to another.

Survey Questions

Thinking about your experiences in your undergraduate studies so far, please indicate how true each statement is for you on a scale of:

1 (Not at all true)
to
5 (Extremely true).

Each question also included a "Not Applicable" option.

Survey questions were adapted from the Basic Psychological Need Satisfaction and Frustration Scale

1. I feel a sense of choice and freedom in what I undertake
2. I feel capable at what I do
3. I really like the people I interact with
4. I feel confident that I can do things well
5. I feel that my decisions reflect what I really want
6. I feel included in the groups that I want to belong to
7. I feel competent to achieve my goals
8. I get along with people I come into contact with
9. I feel my choices express who I really am
10. I feel I am doing what really interests me
11. People are generally pretty friendly towards me
12. I feel I can successfully complete difficult tasks
13. I feel optimistic about my career prospects after I complete my education

Overall Survey Response Rate Summary

Course	Enrollment	# students who took the entry survey	response %	# students who took both entry and exit surveys	response %
CS1	7843	6835	87.1	3847	49.1
CS2	5195	4165	80.2	2455	47.3
CS3	2305	2101	91.1	1088	47.2
total	15343	13101	85.4	7390	48.2

Notes: CS1 includes both Course 1a and Course 1b
CS1/CS2 include data from F17 – F19; CS3 includes data from F18 – F19

Summary of Who Took ALL the Surveys

Summary of responses for those students who took *both* the entry and the exit surveys in CS1, CS2, and CS3 courses from Fall 2017 through (and including) Fall 2019 terms. N = 261

NUMBER OF RESPONDENTS

	Men	Women	Non-Cisgender
Non-URM	142	94	2
URM	12	11	0

PERCENTAGE OF RESPONDENTS

	Men	Women	Non-Cisgender
Non-URM	54.4	36.0	0.8
URM	4.6	4.2	0.0

we focus on these four distinct groups

Let’s look at things at a high level first.

SUM SCORE RESULTS

Mean Values of the Sum Scores

A sum score of 50 translates to an average of about a 3.9/5.0 rating per question.

Honestly, these means are not as high as we were hoping.

The scores trend slightly down, meaning sense of community is weakening slightly. But the groups are not terribly different from each, either, so at least they're all somewhat happy together, I guess?

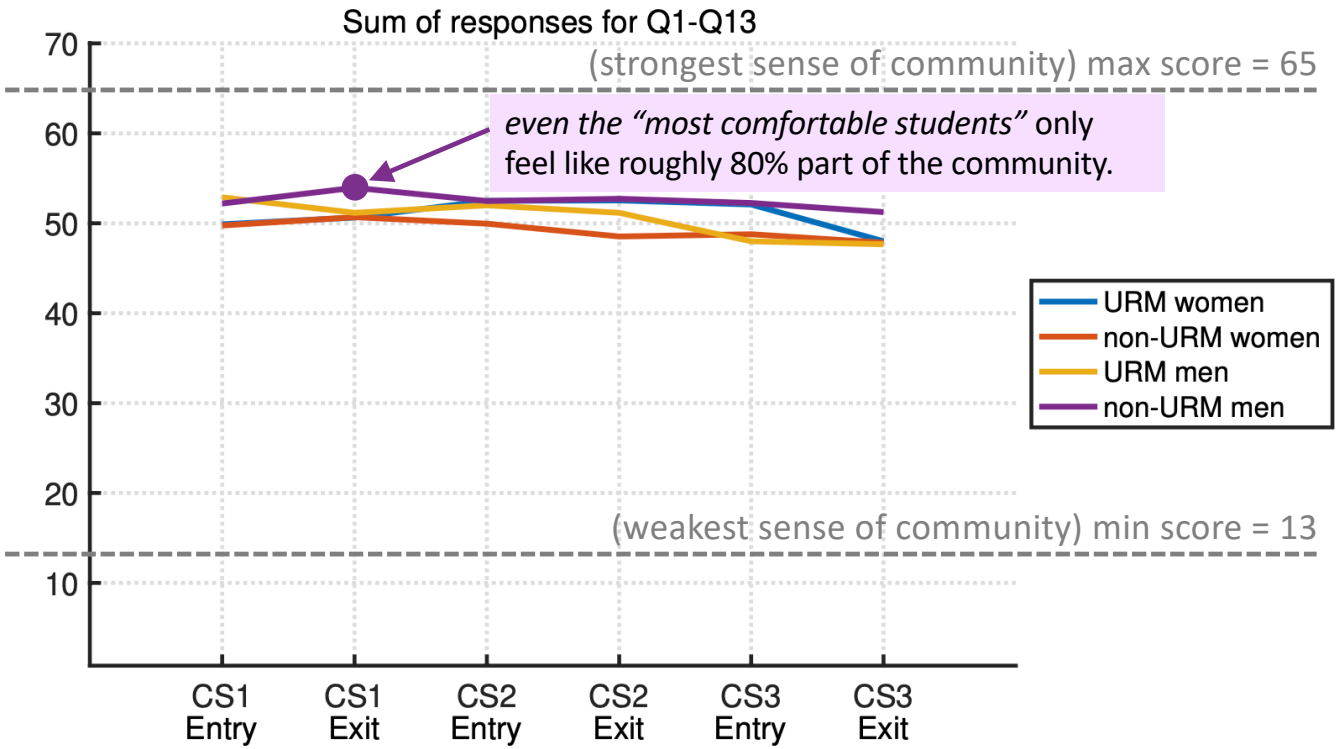


Figure 1: Means of the sum scores (sum of the responses to Q1-Q13).
N = 259; 11 URM women, 94 non-URM women, 12 URM men, 142 non-URM men.

Spread of the Sum Scores

Let's look at the mean values +/- one standard deviation.

Non-URM women and URM men have some of the lower ratings, but also some of the highest!

The darkest shaded area indicates where most students rank their sense of community; it is generally pretty good, but not as strong as we would like to see.

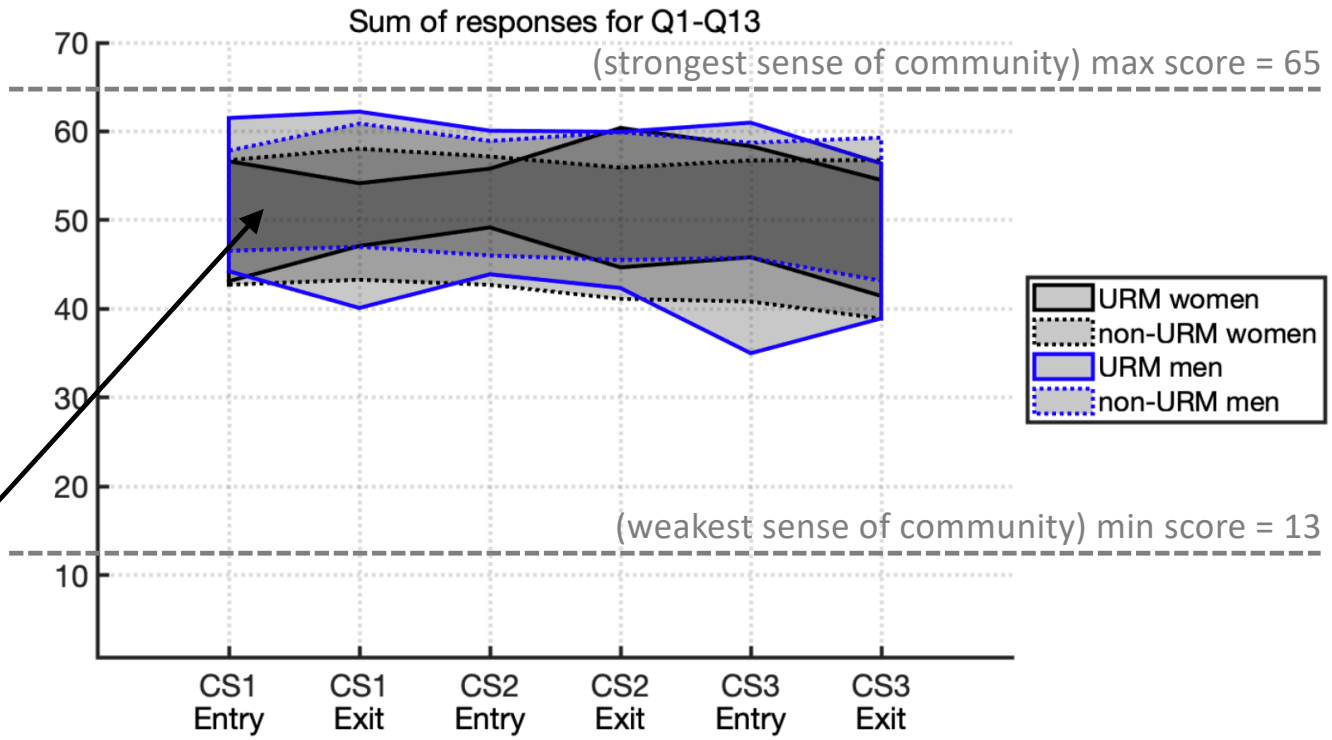


Figure 2: Spread of the sum scores (sum of the responses to Q1-Q13); filled bands are the mean +/- one standard deviation.
N = 259; 11 URM women, 94 non-URM women, 12 URM men, 142 non-URM men.

Want more results? Read the paper. I only got 15 minutes here.

STATISTICALLY-SIGNIFICANT RESULTS

Statistically significant results. Please do not feel compelled to look closely at this giant table of numbers if you don't want to!

All the statistically significant results are negative… that means things got *worse*, not better, as students went through these courses!

Table 4: Statistically significant results of fitting a linear mixed-effects model to the data set ($p < 0.05$).
Effects that also meet the $p < 0.01$ criteria are highlighted in blue.
Effects that also meet the $p < 0.001$ criteria are **highlighted in blue and bolded**.
N = 259; 11 URM women, 94 non-URM women, 12 URM men, 142 non-URM men.

Question	Name	Estimate	SE	tStat	DF	pValue	Lower	Upper
Q1	time	-0.0316	0.0158	-1.9980	1540	0.0459	-0.0626	-0.0006
Q2	time	-0.0426	0.0143	-2.9780	1526	0.0029	-0.0707	-0.0146
Q2	Women	-0.2634	0.0976	-2.6991	1526	0.0070	-0.4548	-0.0720
Q3	time	-0.0302	0.0142	-2.1273	1539	0.0336	-0.0580	-0.0024
Q4	time	-0.0461	0.0157	-2.9357	1539	0.0034	-0.0768	-0.0153
Q4	**Women**	**-0.3784**	**0.0992**	**-3.8142**	**1539**	**0.0001**	**-0.5730**	**-0.1838**
Q5	Women	-0.3209	0.1025	-3.1308	1537	0.0018	-0.5219	-0.1198
Q6	time:URM	-0.1243	0.0423	-2.9360	1528	0.0034	-0.2073	-0.0412
Q7	**time**	**-0.0477**	**0.0144**	**-3.3223**	**1539**	**0.0009**	**-0.0759**	**-0.0196**
Q7	Women	-0.2710	0.0913	-2.9681	1539	0.0030	-0.4501	-0.0919
Q10	Women	-0.2466	0.0988	-2.4949	1530	0.0127	-0.4404	-0.0527
Q11	time:URM	-0.0659	0.0310	-2.1245	1539	0.0338	-0.1268	-0.0051
Q12	**time**	**-0.0466**	**0.0140**	**-3.3347**	**1537**	**0.0009**	**-0.0741**	**-0.0192**
Q12	**Women**	**-0.3512**	**0.0930**	**-3.7752**	**1537**	**0.0002**	**-0.5337**	**-0.1687**
Q13	time	-0.0362	0.0157	-2.3043	1532	0.0213	-0.0671	-0.0054
Q13	Women	-0.3238	0.1078	-3.0040	1532	0.0027	-0.5352	-0.1124
Sum Q1-Q13	time	-0.3607	0.1234	-2.9231	1501	0.0035	-0.6028	-0.1187
Sum Q1-Q13	Women	-2.6631	0.8663	-3.0741	1501	0.0021	-4.3623	-0.9638

Let's Take a Closer Look

For the questions, an effect size > 0.2 would be a "medium to large effect"

An effect size > 0.4 would definitely be a large effect.

All of these are negative results, but many have small effect size so their impact is also small.

The largest and most significant effects impact women.

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Question 4: I feel confident that I can do things well

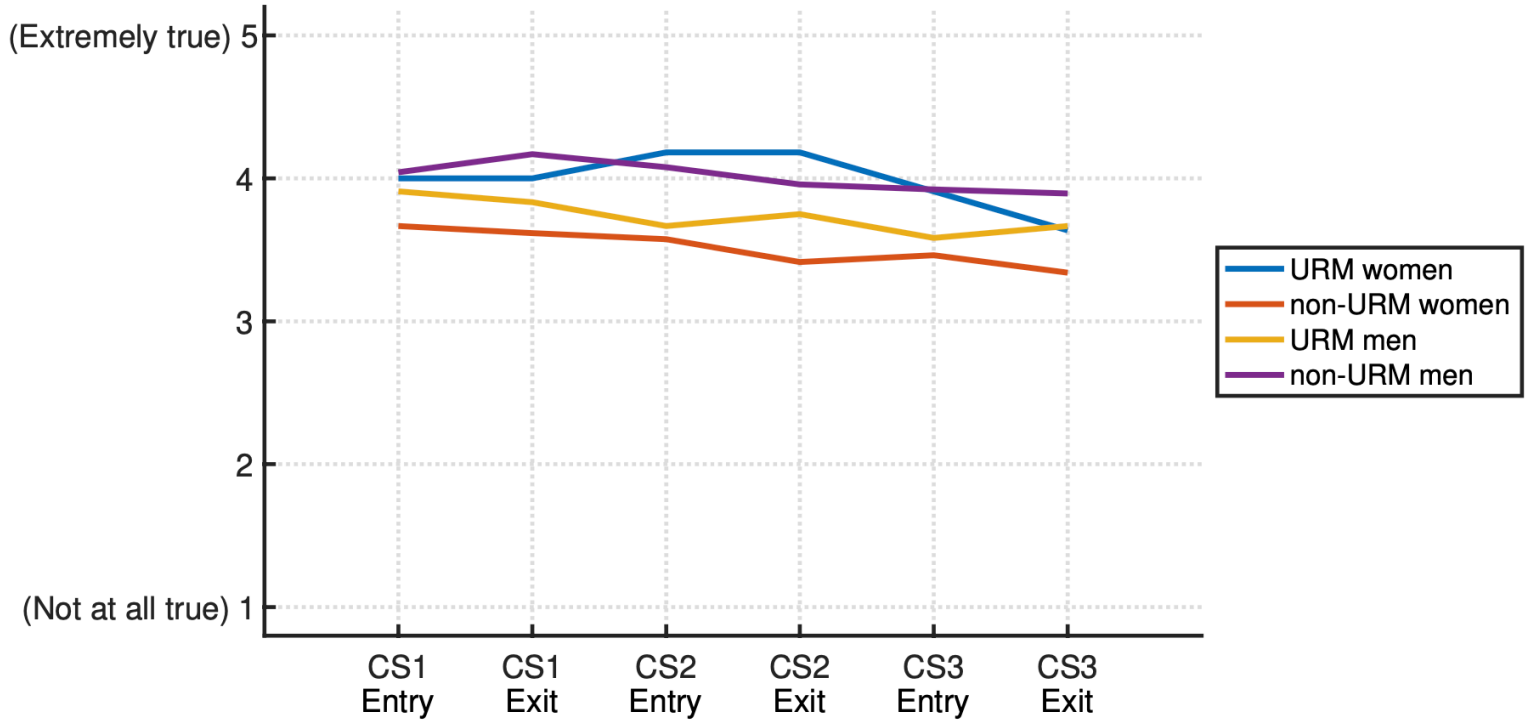

Figure 9: Means of the responses to Question 4.
N = 259; 11 URM women, 94 non-URM women, 12 URM men, 142 non-URM men.

Question 12: I feel I can successfully complete difficult tasks

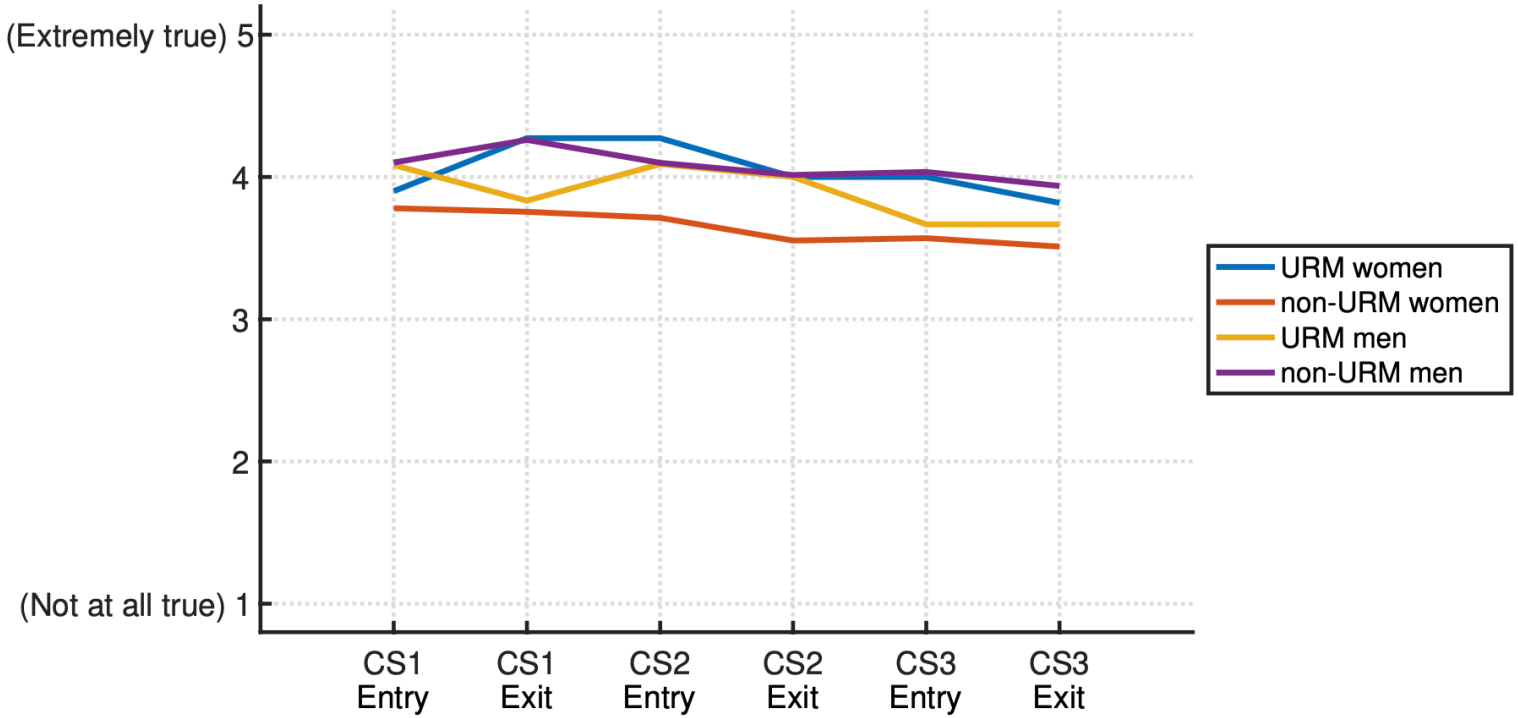

Figure 25: Means of the responses to Question 12.
N = 259; 11 URM women, 94 non-URM women, 12 URM men, 142 non-URM men.

Summary

- All results had negative effects, although in most cases the effect was small.
- These students did *not* report an increase in their sense of community, so we cannot reject the null hypothesis.
  - Overall, though, the ratings were generally on the positive side, with mean values > 3 on a 5-point scale
  - But any individual student could be at-risk of feeling like they don't belong in the community

Summary

- The largest, most significant effects were for women and related to questions on confidence and efficacy
  - URM women appear to be less effected on these questions
- Although the effects are smaller, there is a statistically significant negative effect on URM status + time for questions related specifically to inclusion and climate
  - Q6 *I feel included in the groups that I want to belong to* (-0.1243)
  - Q11 *People are generally pretty friendly towards me* (-0.0659).

Limitations

- This analysis is based on only a small percentage of the students who completed this course sequence.
- This only includes students at our university; we need more data to further investigate if these trends apply to these social groups more generally.

Going Forward

- Do these findings differ if we are able to capture the whole (or nearly the whole) student population taking these courses?
- Do these findings differ after controlling for prior experience, performance in each course, or overall GPA?
- Do these findings differ after controlling for instructor race and gender?

Acknowledgments

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THANKS FOR WATCHING!

Send me an email if you want to talk more: laura.alford@umich.edu