Inequities in undergraduate research experiences: Possible concerns and potential strategies for inclusion

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Undergraduate research leads to an array of benefits for those who participate.

ability to think critically (Bauer & Bennett, 2003; Brownell et al., 2015)

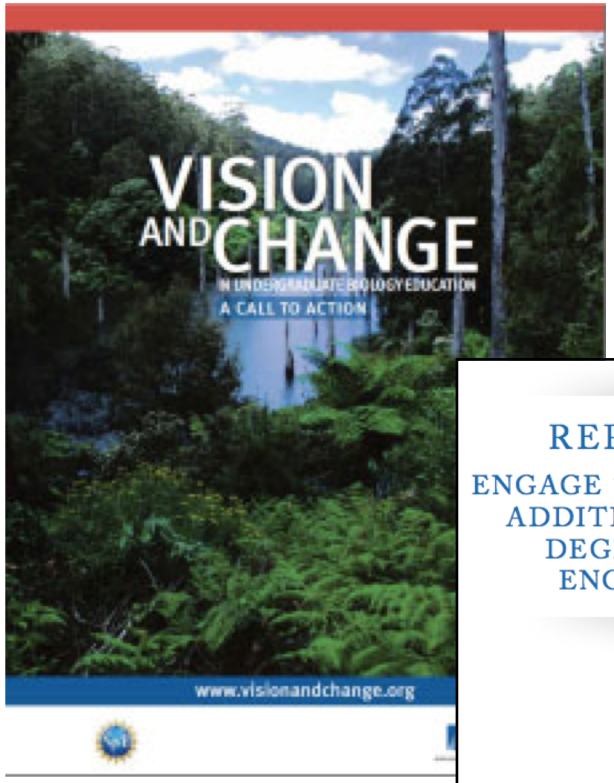
student learning (Brownell et al., 2015; Olimpo et al., 2016)

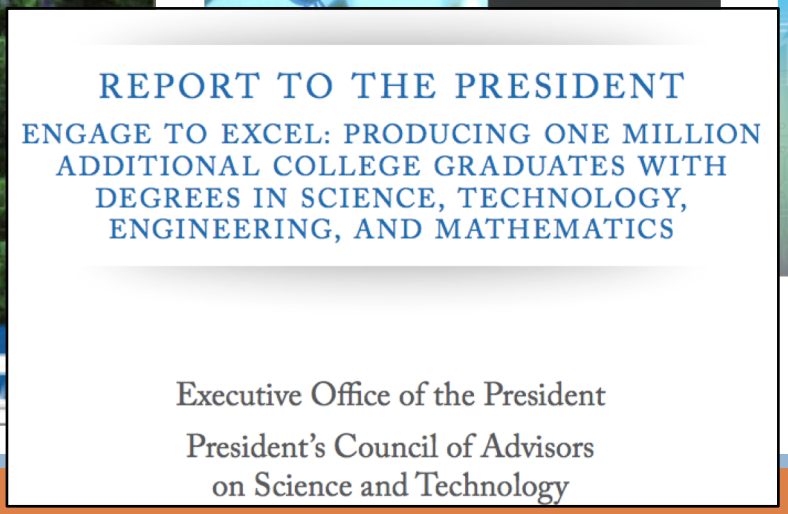
obtaining a bachelor's degree (Jones *et al.,* 2010)

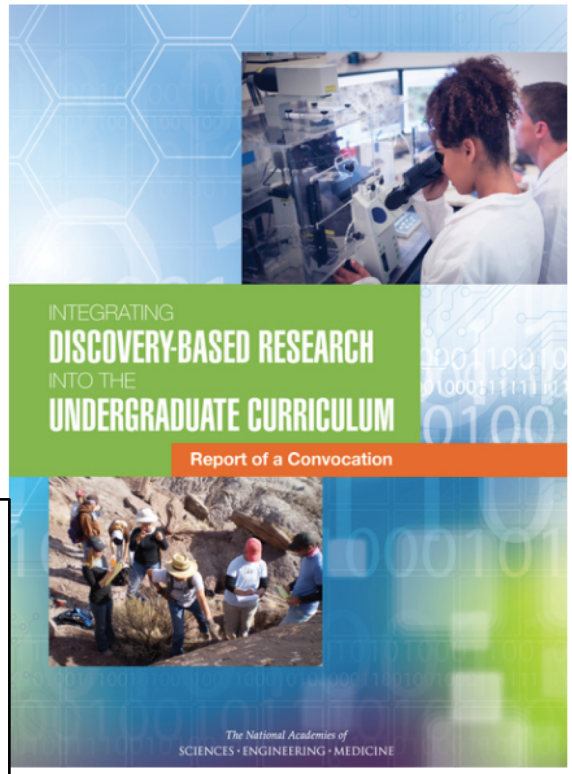
expressing interest in pursuing a PhD (Bauer & Bennett, 2003; Seymour *et al.,* 2004; Russell *et al.,* 2007; Carter *et al.,* 2009; Hurtado *et al.,* 2014)

entering a STEM graduate or professional program (Hurtado *et al.,* 2014)

National recommendations have broadly promoted the importance of undergraduates participating in research







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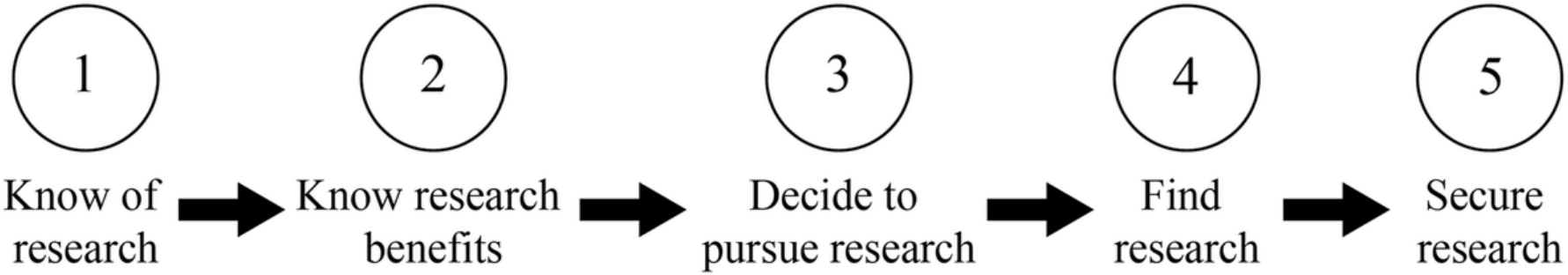

We identified 10 “rules of research” or aspects of scientific research cultural capital that undergraduates reported about finding and securing undergraduate research.

Researchers were more likely than non-researchers to know rules about securing research opportunities:

Emailing multiple PIs

Express interest

Do background research

Be engaged during the interview

Cooper, Cala, Brownell Int J of STEM Ed 2021

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4. There is a selection process for the "best" candidate

5. There are inequities in the experiences of students in undergraduate research and who persists in undergraduate research

Not every research experience is good and despite greater benefits resulting from longer experiences, students leave.

Why do students consider leaving or leave their undergraduate research experiences prematurely?

What are the challenges and negative aspects of research that lead to inequities for students in undergrad research?

Methods

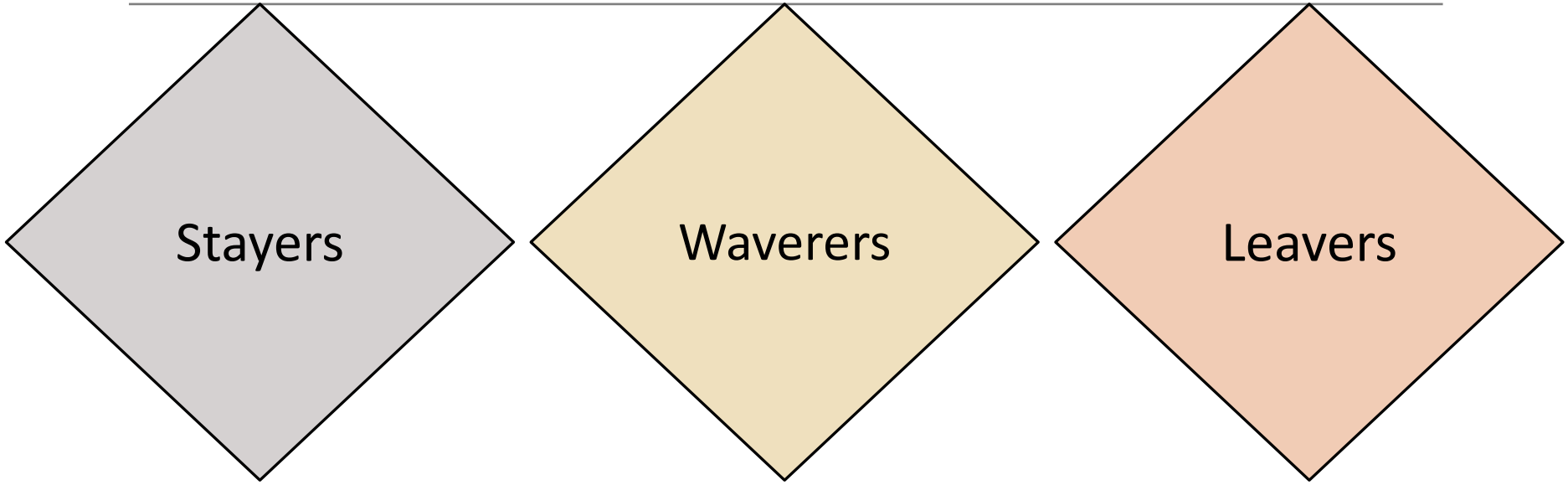
We surveyed 768 life sciences majors across 26 public R1 institutions in the United States who were currently participating in, or had previously participated in, an undergraduate research experience during the academic year. We purposefully recruited through departments, as opposed to targeted programs (e.g. NSF programs) in order to ensure a sample most representative of all undergraduates participating in research.

On the survey we asked:

Whether a student had ever considered leaving their first URE.

Whether a student had actually left their first URE.

Methods

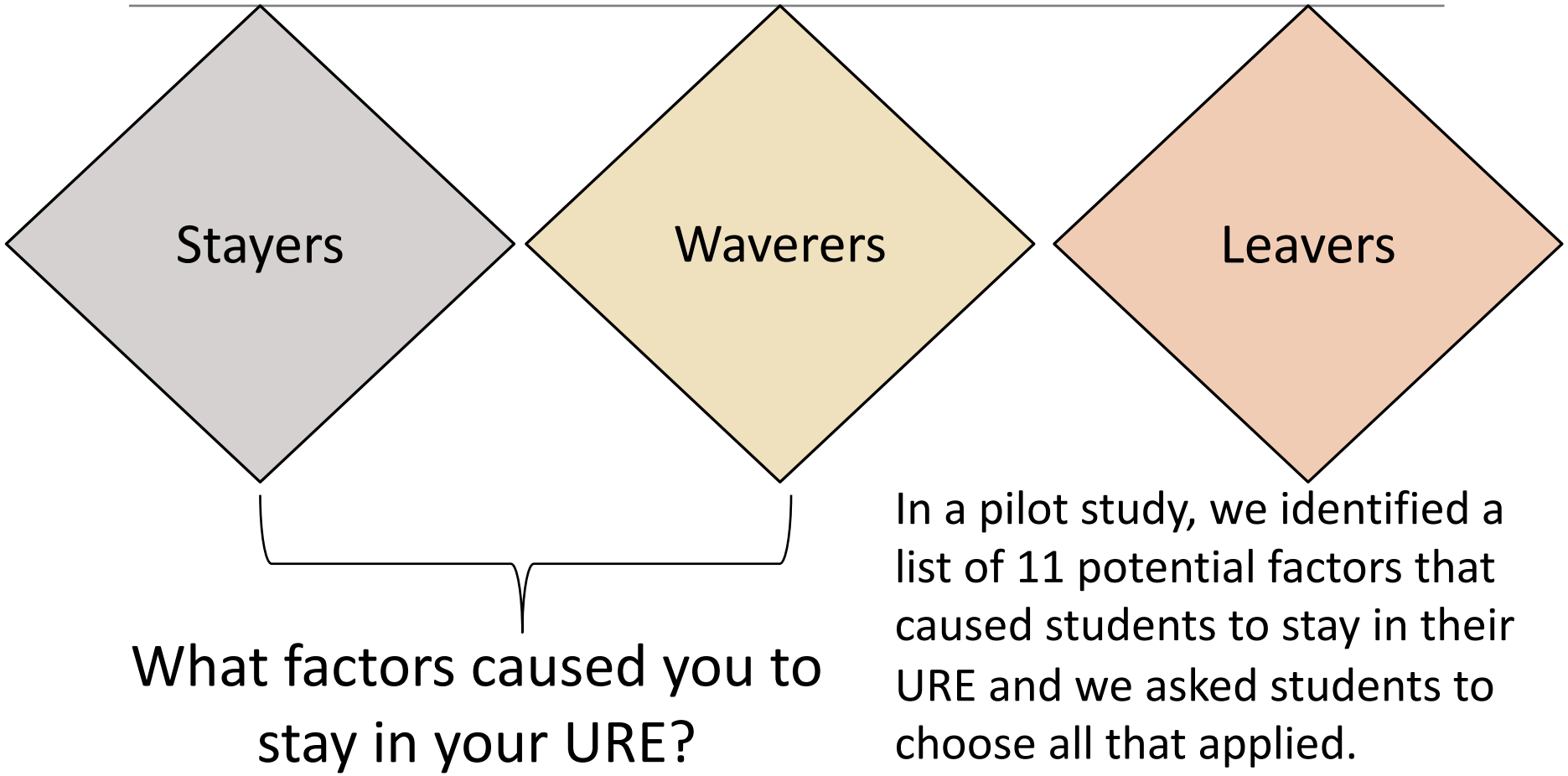


Students who did not ever consider leaving their URE

Students who considered leaving their URE but ultimately stayed

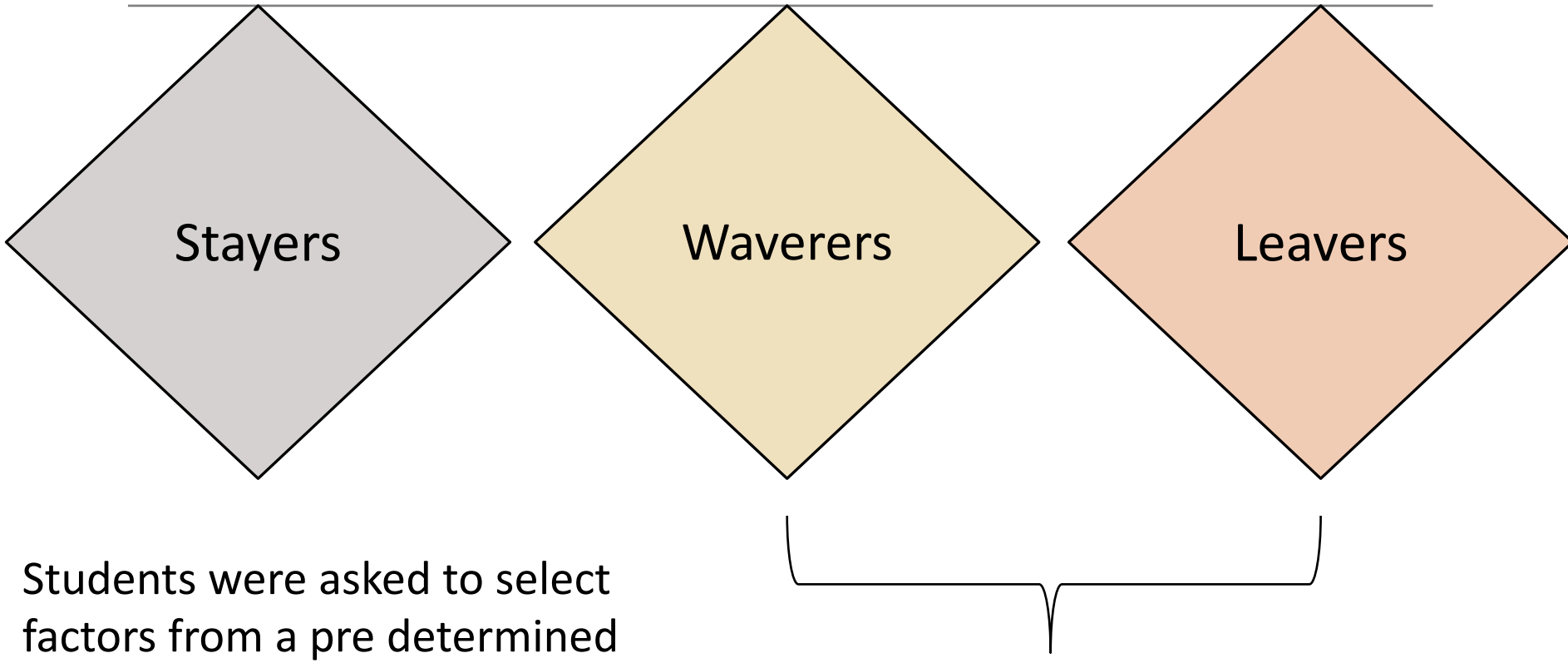
Students who chose to leave their URE

Methods



In a pilot study, we identified a list of 11 potential factors that caused students to stay in their URE and we asked students to choose all that applied.

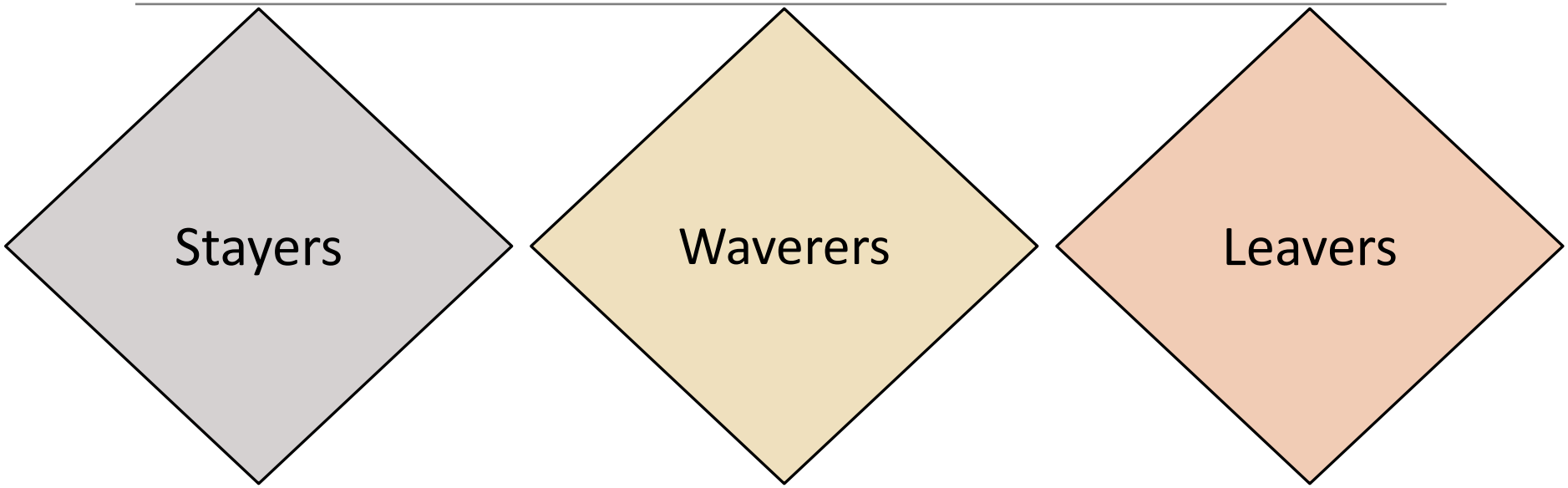
Methods



Students were asked to select factors from a pre determined list that caused them to consider leaving their URE.

What factors caused you to consider leaving your URE?

Methods



The survey collected demographics of students:

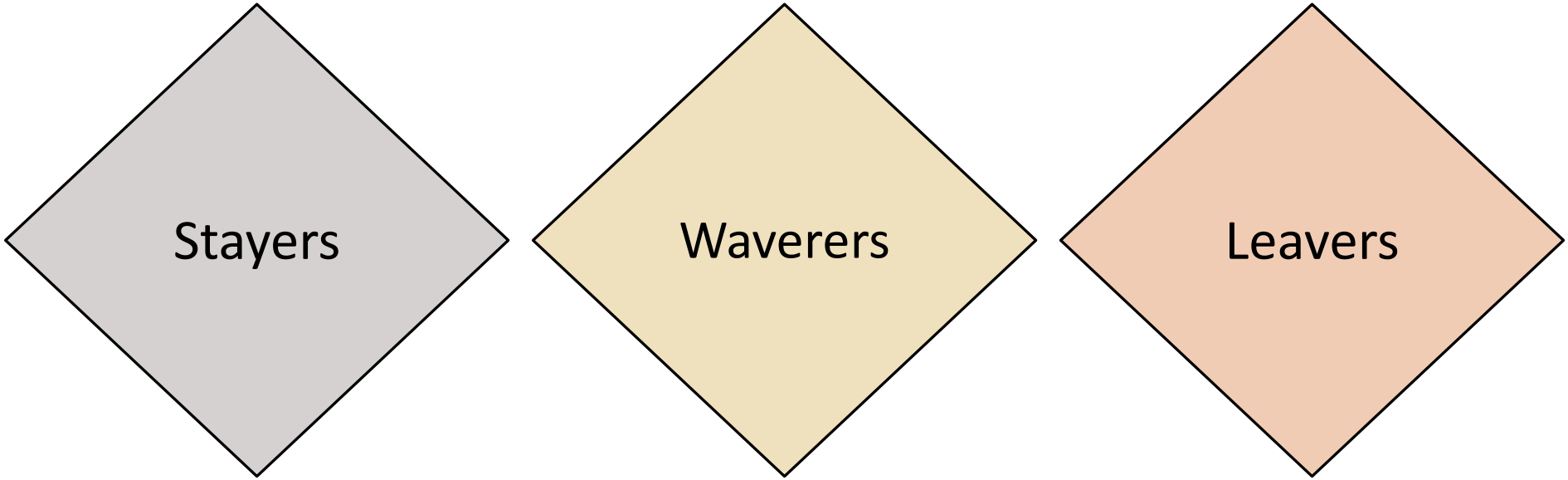
Gender

Race/ethnicity

College generation status

GPA

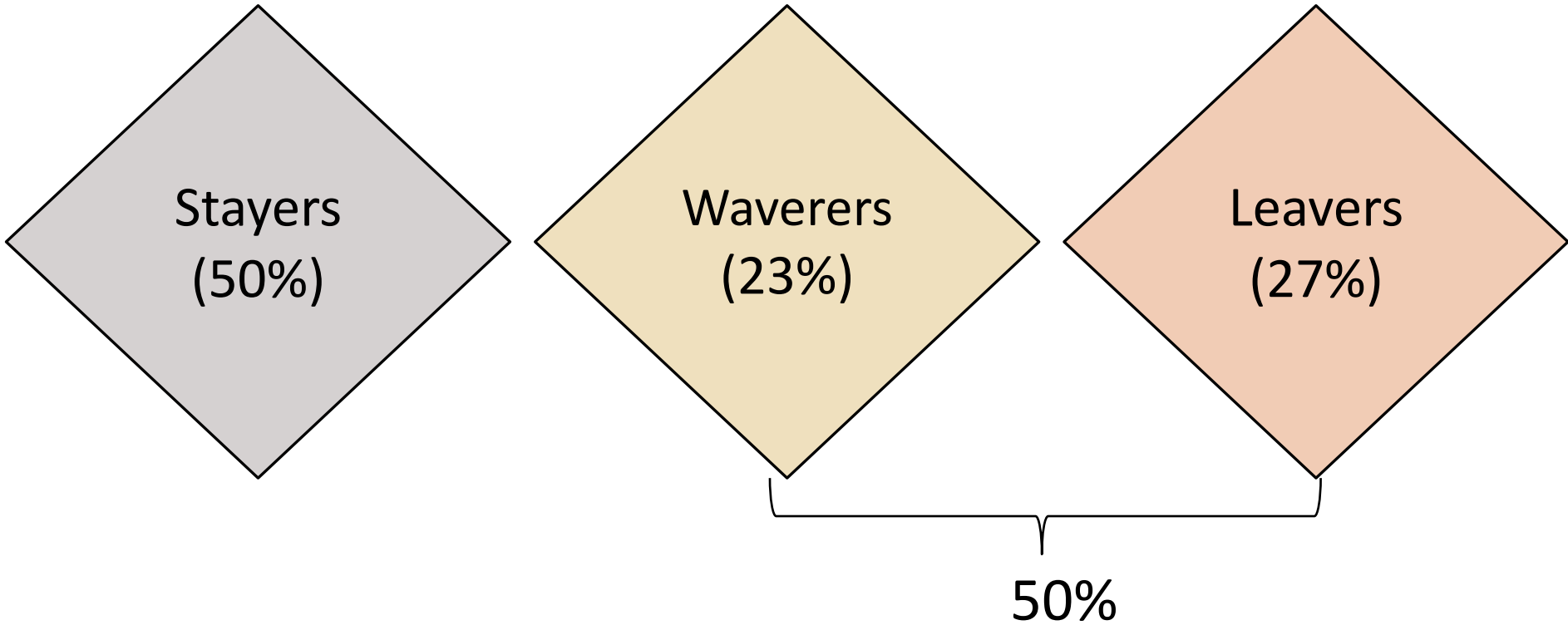
Methods



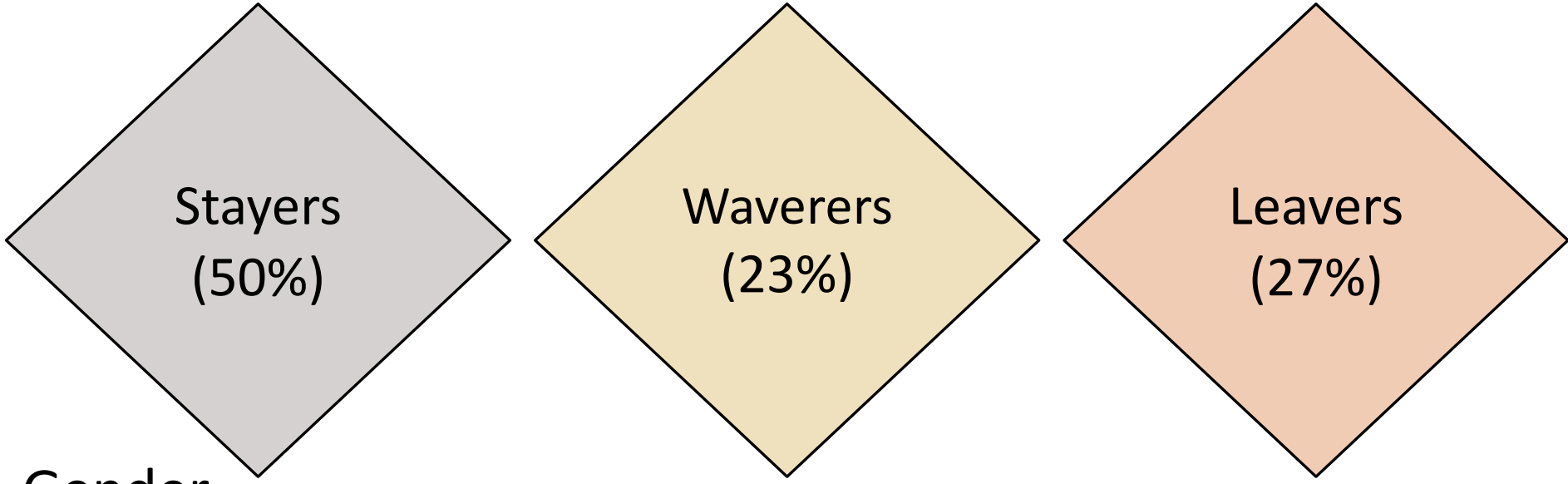
We determined the most common reasons students report for staying in and considering leaving their URE.

We used logistic regression to test to what extent student demographics predicted whether they reported a certain reason for staying in or leaving their undergraduate research experience.

50% of students had considered leaving or left their URE



No significant difference in the % of students who considered leaving research based on:



Gender
Race/ethnicity
College generation status
GPA

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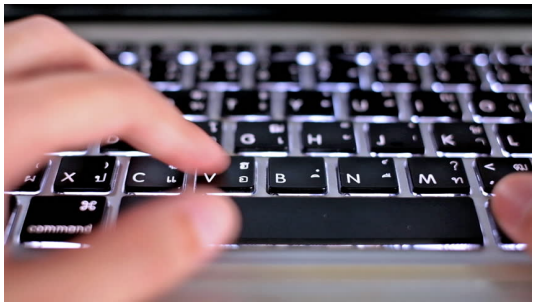

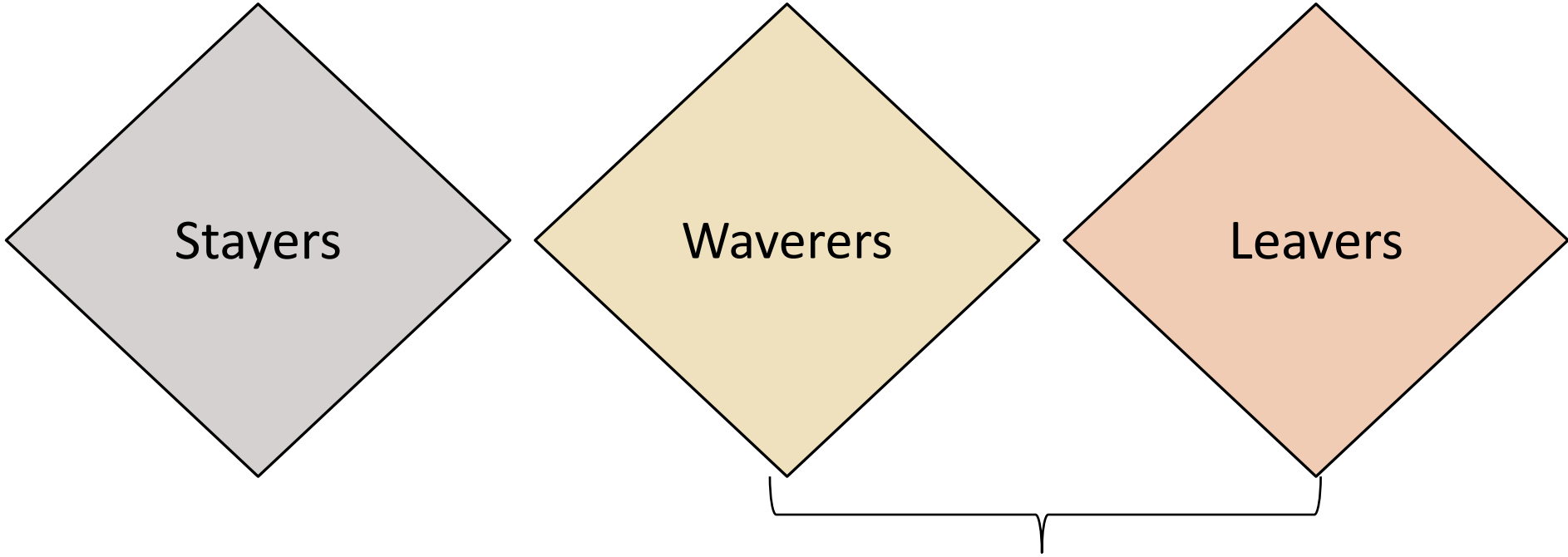

What do you think are the most common reasons for why students <u>considered leaving</u> their UREs?

#1: Student did not enjoy their everyday research task (44%)

Student 290:

"I was not very interested in the topic of the research."

Men were 1.7 times more likely than women to consider leaving research because they do not enjoy their everyday research tasks.

For every one point increase in a student's GPA, they were 2.3 times more likely to consider leaving because they did not enjoy their everyday research tasks.

#2: Student was interested in another research opportunity (39%)

Student 14:

"I considered leaving just because I became more interested in infectious disease research and microbiology than the genetics research we were doing."

#3: Student did not have enough time to do research (38%)

Student 6:
"I was working a part time job and taking full time classes along with research and my grades began to suffer as a result."

For every one point decrease in a student's GPA, they were 2.1 times more likely to consider leaving because they do not have enough time to do research.

#4: Student did not have sufficient guidance for their research project (32%)

Student 199:

"My mentor provided me with very little training. I felt as if she had no time to meet with me or provide hands-on guidance. (…) Not once during this time did she check my procedures or results."

Cooper et al., PLoS One, 2019

#5: Student's mentor (PI, post-doc, grad student or staff member in charge of their research) (32%)

Student 345:

"The supervisor would constantly berate me and the other undergrads about how we were not good enough and were lazy (we were not)."

What factors predicted whether a student would actually leave their URE?

We conducted a logistic regression to see whether selecting any of the 11 factors predicted whether a student would actually leave their URE.

Students who reported **a negative lab environment** were 1.6 times more likely to choose to leave their URE than students who did not report a negative lab environment ($p = 0.04$).

Students who thought they were not **gaining important skills or knowledge** were 2.1 times more likely to leave their URE than students who did not report this ($p = 0.02$)

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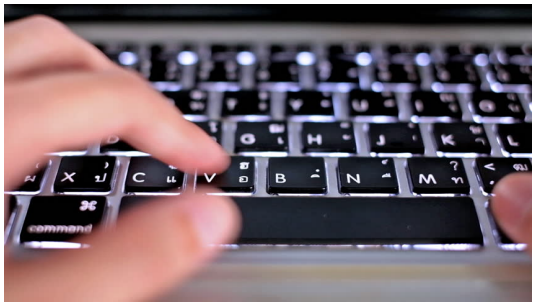

What do you think are the most common reasons for why students stayed in their URE?

Cooper et al., PLoS One, 2019

#1: Student is gaining important skills or knowledge (85%)

Student 657:"I felt that there were many things I could learn and practice."

Continuing generation college students were 1.9 times more likely than first generation college students to stay in research because they are gaining important skills or knowledge.

Cooper et al., PLoS One, 2019

#2: Research is important for student's future career (84%)

Student 610: "I am currently staying because I require research lab experience for graduate school."

Men were 1.9 times more likely than women to stay in research because it is important for their career.

Cooper et al., PLoS One, 2019

#3: The lab is flexible with student's time or schedule (82%)

Student 340: "My lab is really nice about being understanding of my schedule as a student and of all the other time commitments I have."

#4: Student's mentor (PI, post-doc, grad student or staff member in charge of their research) (78%)

Student 6: "My mentor cares for me not only as a research assistant but as a person."

Cooper et al., PLoS One, 2019

#5: Student is interested in their research topic (73%)

Student 88: “I love the work that we do. [I] am genuinely interested in the results/projects.”

Cooper et al., PLoS One, 2019

What factors predicted whether a student would not consider leaving their URE?

We conducted a logistic regression to see whether selecting any of the 11 factors predicted whether a student never considered leaving their URE.

Students who reported **a positive lab environment** were 2.7 times more likely to never consider leaving their URE than students who did not report a positive lab environment ($p < 0.001$).

Students who reported **enjoying their everyday research tasks** were 2.0 times more likely to never consider leaving their first URE than students who did not report enjoying their everyday research tasks ($p = 0.003$)

Cooper et al., PLoS One, 2019

Conclusions

Most frequently reported factors that cause students to <u>stay</u> in their URE

1. Gaining skills and knowledge
2. Research is important for career
3. Lab is flexible with time/schedule
4. Student's research mentor
5. Interested in research topic

Most frequently reported factors that cause students to <u>consider leaving</u> their URE

1. Do not enjoy research tasks
2. Interested in another research opportunity
3. Do not have enough time to do research
4. Do not have sufficient guidance
5. Student's research mentor

Stayers ← Waverers → Leavers

Factors that significantly predict that a student will never consider leaving their URE

1. Positive lab environment
2. Enjoys research tasks

Factors that significantly predict that a student will leave their URE

1. Negative lab environment
2. Not gaining important skills or knowledge

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Do these findings replicate across institution types?

Gin et al., under review

Replicated this study with students at:

- 12 private R1s (n = 248)
- 30 master's granting institutions (n = 150)
- 20 primarily undergraduate institutions (PUIs) (n = 104)

Stayers ← Waverers → Leavers

Students at public R1s are more likely to consider leaving their undergraduate research experiences compared to students at Master's-granting institutions and PUIs.

	Considered leaving URE
Institution type	
Public R1 (n = 760)	49.5%
Private R1 (n = 248)	52.4%
Master's (n = 150)	22.0%***
PUI (n = 104)	31.7%***

Compared with students from 25 public R1s (n =760), we found that students at Master's granting institutions were 4.5 times less likely to actually leave their URE and students at PUIs were 2.8 times less likely to actually leave their URE.

*** $p < 0.001$

Do these findings replicate across institution types?

Gin et al., under review

However, there were very few significant differences in the percentage of students from different institution types who selected particular reasons for why they chose to stay in or considered leaving their URE.

It is notable that "I did not enjoy my everyday research task" was the most common reason for why students left UREs at public and private R1s but not for why students left UREs at Master's granting and PUIs.

Growing body of literature on inequities and concerns in undergraduate research: people and environment

Negative mentoring: Undergraduate researchers reported seven major ways they experienced negative mentoring: absenteeism, abuse of power, interpersonal mismatch, lack of career support, lack of psychosocial support, misaligned expectations, and unequal treatment (Limeri et al. 2019).

Students with depression: Lab environment and social connections can negatively impact their depression (Cooper et al. 2020).

Students with disabilities: Lack of accommodations provided by mentors in the research lab (Gin et al. under review)

Students with anxiety: Failure, insufficient mentoring, and the negative response of people to failure can exacerbate anxiety, which is more likely to affect women (Cooper et al. in prep)

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So what are potential solutions and strategies to mitigate these inequities?

What can we as mentors do to mitigate some of these challenges?

Insufficient guidance
Increased anxiety and depression
Caused students to leave research

Provide (the student's perception of) sufficient guidance

Lack of skills and knowledge
Increased anxiety
Caused students to leave research

Backward design experiences to ensure students gain skills/knowledge *(Cooper et al., 2017)*

Negative mentor relationships
Increased anxiety and depression
Caused students to leave research

Build relationships
Praise and encourage mentees

Negative lab environment
Increased anxiety
Caused students to leave research

Set the tone for a positive, collaborative environment

CBE—Life Sciences Education
Vol. 13, 602–606, Winter 2014

Essay

Course-Based Undergraduate Research Experiences Can Make Scientific Research More Inclusive

Gita Bangera*† and Sara E. Brownell†‡

*Bellevue College, Bellevue, WA 98007; ‡School of Life Sciences, Arizona State University, Tempe, AZ 85287

High enrollment CUREs (or many low enrollment CUREs) increase the number of research opportunities, increasing access

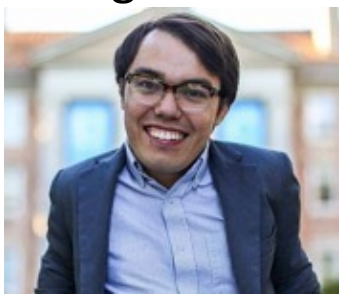
Require students to enroll in a CURE as part of their normal curriculum, so students don't have to know the unwritten rules of research and faculty don't have to select the students, which removes barriers to participation

Structure of the CURE can help with mentor support

Acknowledgements

Katey Cooper

Logan Gin



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Questions?

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Cooper KM, Gin L, Akeeh B, Clark CE, Hunter JS, Roderick TB, Elliott DB, Gutierrez LA, Mello RM, Pfeiffer LD, Scott RA, Arellano D, Ramirez D, Valdez EM, Vargas C, Velarde K, Zheng Y, Brownell SE. **Factors that predict biological sciences student persistence in undergraduate research experiences.** PLoS ONE. 2019.

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