EXPLORING DOCTORAL STUDENTS' SENSE OF BELONGING, RELATIONSHIPS WITH ADVISORS, AND ACADEMIC ENGAGEMENT IN THE PHYSICAL AND BIOLOGICAL SCIENCES

PROGRAM EVALUATION REPORT (SUMMER 2020)
CENTER FOR STATISTICAL ANALYSIS IN THE SOCIAL SCIENCES

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About the Report

In Summer 2019, a research team conducted a needs assessment of graduate students enrolled in doctoral programs in the Division of Physical and Biological Sciences (PBSci). Broadly, the goals of the study were (1) to assess graduate students' different experiences in their departments, including various aspects related to the graduate experience, and (2) to derive implications and recommendations for improvement from the analysis of quantitative and qualitative data. This report stems from previous portions of a larger, more comprehensive report written by the core research team and shared internally to key stakeholders.

Author Contributions

This needs' assessment study was conducted by a research team consisting of two graduate student researchers (Giselle Laiduc and Emily Hentschke) and Dr. Anna Sher, the assistant director for Assessment and Survey Research in IRAPS. Giselle Laiduc and Emily Hentschke developed the survey instrument and interview protocols by reviewing extensive literature in psychology and education research, Anna Sher also provided extensive feedback on survey materials. Emily Hentschke and Giselle Laiduc performed quantitative data analyses and interpretation under the supervision of Anna Sher. Emily Hentschke conducted all interviews and completed preliminary thematic analyses of interviews and open-ended survey data with support from Giselle Laiduc.

This program evaluation report, prepared for the Center for Statistical Analysis in the Social Sciences, was written by Giselle Laiduc with feedback from Anna Sher and Doug Bonett.

Acknowledgements

The doctorate is among the most advanced degrees attainable in higher education. To enter a doctoral program, students must undergo a highly selective and competitive application process (Ali & Kohun, 2006). Consequently, doctoral students tend to represent some of the most highly qualified and successful students. However, attrition in doctoral education is quite high. About half of all doctoral students will leave their programs before they complete their degrees (Walker et al., 2008).

Despite the notable overall increase in the number of underrepresented racial/ethnic minority students completing STEM doctoral programs, these groups of students remain underrepresented partly as a result of higher attrition rates compared to their peers (Sowell et al., 2015). Research has underscored the importance of students' sense of belonging (e.g., Austin, 2002; Fisher et al., 2019; Good et al., 2012; Hausmann et al., 2009; Lovitts, 2001; Smith et al., 2013) and the advisor-student relationship for students' overall satisfaction with the graduate experience and degree completion (Lovitts, 2001; National Academies of Sciences, Engineering, and Medicine, 2018; O'Meara et al., 2013; Zhao et al., 2007). To increase the completion rates of underrepresented racial/ethnic minority students, STEM doctoral programs must understand the needs and experiences of their students and foster environments that adequately support diverse students' wellbeing and success.

As part of a needs assessment requested by the university administration, this mixed-methods study examined the experiences of doctoral students enrolled in the physical and biological sciences at an R1 university. In this report, we focus specifically on examining underrepresented students' sense of belonging, perceptions of advisor support, and academic engagement.

Context of the Study

Within the last 20 years, UC Santa Cruz's Division of Physical and Biological Sciences (PBSci) has admitted more graduate students into its programs. The PBSci graduate student population has increased by over a factor of 1.5, with 383 students in Fall 1998 to 585 students in Fall 2018 (see Table 1). With this increasing enrollment, the PBSci graduate population has become increasingly diverse. For example, compared to Fall 1998, PBSci has more than three times as many African American/Black and Latinx graduate students. PBSci also has slightly increased the number of women among graduate students; as of Spring 2019, 44% of PhD students identified as women compared to 40% in Fall 1998 (UCSC IRAPS).

Table 1

Racial/ethnic background of PBSci PhD Students (1998-2008)

	Fall 1998		Fall 2008		Fall 2018	
Race/Ethnicity	Number	Percent	Number	Percent	Number	Percent
African American/Black	4	1.0%	5	1.1%	17	2.9%
Amer. Indian/Alaskan Native	0	0%	3	0.7%	10	1.7%
Asian American	25	6.5%	37	8.2%	61	10.4%
Latinx	19	5.0%	33	7.3%	68	11.6%
Pacific Islander	3	0.8%	1	0.2%	0	0%
White (non-Hispanic)	244	63.7%	258	57.5%	301	51.5%
International	40	10.4%	42	9.4%	92	15.7%
Unknown	48	12.5%	70	15.6%	36	6.2%
Total	383	100%	449	100%	585	100%

Although the demographic landscape of doctoral students in PBSci has changed, no systematic, in-depth examination has been conducted to determine whether the division and its departments have been able to meet the needs of its diverse students. In Summer 2019, a research team consisting of two graduate student researchers and the assistant director of the Institutional Research, Assessment, and Policy Studies (IRAPS) designed and conducted a needs assessment with two main goals: (1) to identify and describe concerns related to doctoral students' well-being and success, and (2) to derive implications and recommendations for improvement from the analysis of quantitative and qualitative data. Finally, the research team worked with the key stakeholders from the PBSci Division, Division of Student Success, and Division of Graduate Studies to review the findings and develop recommendations.

Research Questions

We focused on the following three research questions to evaluate the student experiences:

1. Do students feel a sense of belonging within their departments? Within their labs? Do students from historically-marginalized backgrounds (e.g., first-generation, working-class, Students of Color) report different perceptions of belonging compared to their peers?
2. Are students able to build positive relationships with faculty? If so, what contributes to these positive relationships? If not, what factors inhibit students from building these relationships? Do students perceive that their advisors[1] believe in them? Do students from historically-marginalized backgrounds differ in these perceptions from their peers?
3. How prevalent are feelings of academic burnout and exhaustion? Do students from historically-marginalized groups report different feelings from their peers?
4. What are students' own suggestions for how to improve their graduate experiences?

METHODS

In consultation with the key stakeholders, the research team selected a multi-method approach: 1) a confidential survey containing both open- and close-ended items, and 2) individual interviews with graduate students. The participants, materials, and procedures for each method are discussed below.

SURVEY

Survey participants

Of the 538 PhD students invited to participate in the survey, 29% responded (*n*=156). To ensure participant confidentiality, the research team did not collect any detailed demographic information (e.g., race/ethnicity, departments) that could reasonably identify individual participants by linking them with their survey responses. Instead, the research team constructed a brief demographic form with broad questions outlined in the survey materials below. See Table 2 for the demographic breakdown of survey participants and Table 3 for information on the terms used to describe students' demographic backgrounds.

IRAPS ran a separate analysis using institutional data and provided information on the survey respondents. Participants represented each of the ten PhD programs within the PBSci Division. The survey participants consisted of students from diverse gender and ethnic backgrounds, though their

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[1] The term "advisor" also refers to the students' principal investigator.

response rates varied. For example, 40% of the enrolled women and 20% of enrolled men responded to the survey. In terms of racial/ethnic identity, 35% of enrolled Black, Latinx, and Native students, 28 % of Asian American, 33% of White students, and 22% of international students responded to the survey. Given that the overall response rate was 29%, some groups (e.g., men, international students) were somewhat underrepresented among survey participants.

Survey instrument

Drawing from prior research in education and psychology and other campus assessments conducted across campus, the research team developed a new survey instrument using pre-established scales detailed below. The online survey instrument included both close- and open-ended questions to assess various facets of the graduate student experience.[2] The author includes only relevant measures from psychology and education research that the team adapted to the context of graduate education for this report below.

Belonging to the department and research group. We assessed students' sense of belonging to their department using the 8-item acceptance subscale of the Sense of Belonging scale (Good et al., 2012). We adapted the subscale to the context of the department (α = .94, M = 4.23, SD = 1.01; e.g., "When I am in a department setting, I feel accepted") and to the research group (α = .96, M = 4.58, SD = 1.13; e.g., "When I am with my research group/lab, I feel accepted"). Participants indicated their level of agreement of items on a scale of 1 (strongly disagree) to 6 (strongly agree). Higher scores indicate higher belonging.

Relationships with faculty. We asked students to respond yes or no to an open-ended item, "Are there any professors in your department that you have felt that you could relate to or build a relationship with?" and then asked them a follow-up question depending on their answer (i.e., "Why do you think you cannot relate to or build relationships with professors in your department?" or "What about this/these professor(s) make it so that you can relate to or a build relationship(s) with them? For example, are there certain characteristics that they have that make it easier for you to relate to them?").

Perceptions of advisors' beliefs about students. We assessed students' perceptions of their advisors' beliefs about them using a modified 8-item Relation-Inferred Self-Efficacy scale (Chen et al., 2004). Participants indicated their agreement from 1 (strongly disagree) to 6 (strongly agree), with example items such as "My advisor believes that I can perform effectively on many different academic/professional tasks" and "My advisor believes that when I am facing difficult academic/professional tasks, I will accomplish them." Higher scores indicate participants' higher beliefs that their advisor believed in them (α = .98, M = 4.71, SD = .91).

Academic engagement. We measured academic engagement using the 5-item Utrecht Work Engagement Scale for Students (Schaufeli et al., 2002). Participants rated how frequently they experienced each of the items (e.g., "I am enthusiastic about my studies") on a scale of 1 (never) to 5 (always). Higher scores indicate more frequent feelings of engagement (α = .82, M = 3.74, SD = .68).

Academic burnout. We measured academic burnout with two subscales of the Maslach Burnout Inventory[3] (Schaufeli et al., 2002) that we adapted to the university and graduate context. The subscales measured exhaustion (5-items, α = .89, M = 3.04, SD = .84; "I feel burned out from my studies/research") and cynicism (4 items, α = .84, M = 2.82, SD = .98; e.g., "I doubt the significance of my

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[2] The overall PBSci needs assessment is much more comprehensive, including many different measures related to the goals outlined by key stakeholders. For this report, the author focuses on only a few measures.

[3] The Maslach Burnout Inventory also included a subscale that measured academic self-efficacy, but because of low internal consistency among items (α = .62), we excluded it from analyses.

studies"). Participants rated how frequently they experienced each of the items on a scale of 1 (never) to 5 (always). Higher scores indicate more frequent feelings of exhaustion and cynicism.

Student demographics were recorded by a brief questionnaire. To protect student identity, the demographic questionnaire contained general questions that could not reasonably identify participants and that could not be captured through institutional records (i.e., whether they identified as a Person of Color, their gender identity, college generation status[4], candidacy status, social class background).

Survey procedure.

The research team recruited participants through a series of emails sent by IRAPS during the Summer of 2019. The emails contained an individualized link to a survey hosted on the Qualtrics survey platform, which allowed participants to revisit the survey at any point before submitting. To emphasize the collaborative nature of the needs assessment, individual departments, the associate dean, and the dean of the PBSci division also sent out email reminders to their respective listservs. The research team collaborated with the IRAPS analyst who oversaw data collection and provided deidentified survey responses to the research team for analysis. The survey was open from August 19 to September 13, 2019. All students who completed the survey were entered in a raffle to win a $100 Amazon electronic gift card.

INTERVIEW

Interview participants

A member of the research team interviewed 20 PhD students. The interview participants were relatively diverse in gender, race/ethnicity, and social class background (see Table 2). As for college generation status, 90% of participants identified as first-generation (i.e., neither of their parent(s)/guardian(s) had obtained a four-year degree) and 10.0% as continuing-generation (i.e., at least one parent/guardian has obtained a four-year degree). In this sample, 55% had not yet advanced to candidacy while 45% had already advanced (determined by whether they have completed their comprehensive or qualifying exams).

Table 2

Demographic breakdowns of survey and interviews participants.

	Survey participants (*n*=157)		Interview participants (*n*=20)	
	Number	Percent	Number	Percent
Gender				
Women	68	43.3%	11	55.0%
Men	82	52.2%	8	40.0%
Did not report/Unknown	7	4.5%	1	5.0%
Race/Ethnicity				
PoC	44	28.3%	8	40.0%
Non-PoC	84	54.5%	12	60.0%
Did not report/Unknown	28	18.1%	-	-
Socioeconomic status				

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[4] First-generation college students are students who reported that neither parent(s)/guardian(s) have obtained a four-year degree in the US. Continuing generation (CG) students are those students who had at least one parent/guardian obtain a four-year degree in the US.

SES Group 1	54	34.4%	8	40.0%
SES Group 2	84	53.5%	12	60.0%
Did not report/Unknown	19	12.1%	-	-
College generation status				
First-generation	54	34.4%	8	40.0%
Continuing-generation	84	53.5%	12	60.0%
Did not report/Unknown	19	12.1%	-	-
Candidacy status				
Not Advanced	63	40.1%	11	55.0%
Advanced	77	49.0%	9	45.0%
Did not report/Unknown	17	10.8%	-	-
Nationality				
Domestic	130	32.8%	18	90%
International	26	16.6%	2	10%
Did not report/Unknown	1	0.6%	-	-

Note: Though the research team conducted 2 interviews with international students, we excluded their data from analyses.

Interview procedure

The research team recruited interview participants by one of two ways. First, students received an email from the associate dean describing the scope of the study (i.e., to gain a better understanding of students' needs, experiences, and opinions on what is working and what needs improvement in the division) that contained a link to an interview pre-screening sign-up form. Second, at the end of the online survey, participants read a short description about the interviews and could sign up for an interview by following a link to the same sign-up form.

The sign-up form collected basic contact information (e.g., name, email, availability) and open-ended questions where students could self-report their different identities and any particular issues or specific experiences they wanted to discuss. The form also contained questions to ensure eligibility (i.e., students must be domestic students enrolled in a doctoral program) determined prior to recruitment by key stakeholders in order to prevent overlap with other needs assessments occurring across campus.

Because of resource constraints (i.e., time, funding), the research team invited only a small subset of interested interview participants. To hear the perspectives of students from various demographic backgrounds, the research team prioritized invitations to students who had specific identity-based experiences. A graduate student researcher conducted semi-structured individual interviews during a three-week timespan on campus, away from any PBSci buildings, in an effort to provide a more comfortable setting for participants to share their experiences. Interviews lasted between 45-60 minutes and were audio-recorded. During the interview, participants completed an identity chart reflection activity, in which they self-described and noted their most salient identities to their graduate experience. The interviewer used this chart to guide conversations throughout the interview. The semi-structured interview focused on how students' various identities impacted their perceptions of their graduate experience, including conversations about belonging, relationships with advisors, faculty, and peers, experiences of discrimination and harassment, sense of climate and acceptance of diverse communities; recommendations to improve graduate student support, and reflection on the graduate experience at UC Santa Cruz.

After the interview, participants completed a demographic questionnaire, received $20 cash, and were thanked for their participation. The interviews were transcribed and checked for accuracy by the research team. The university's Institutional Review Board approved all procedures and materials.

DATA ANALYSIS METHODS

Quantitative analyses

The research team analyzed all quantitative data using version 25 of the IBM SPSS Statistics software. For the overall analyses, the team applied a weight to ensure that the reported survey results adequately represent the PBSci student population in terms of gender, race/ethnicity, and international/domestic status. See Table 3 for more information on these demographic groups, including how the team constructed groups for analyses.

To analyze and report data, the research team used a two-step approach. First, to examine possible relationships between facets of students' experiences, we created specific scales (indices)[5] by computing the average of the items measuring a given facet. We calculated basic descriptive information (e.g., means, standard deviations) and correlations between the indices.

Second, to evaluate the quality of the program, the research team dichotomized index scores into two categories based on a point of critical difference, distinguishing between positive and negative experiences. This approach allowed the research team to determine whether the majority of students reported positive or negative experiences in any given area, indicating areas where improvement is needed. In addition, we used chi-squared analyses to identify areas where students from historically-marginalized backgrounds had significantly different experiences or perceptions compared to their peers.

Because scales differed in their scale ratings (e.g., frequency, agreement), the author notes the specific analytic approach within each section. For clarity and ease, the author reports only significant differences in the body of the report. For reference, the author includes analyses of other comparisons in the appendices.

Table 3

Terms used to identify demographic groups in this report.

Group	Definition/Notes for Analyses
Gender	In the survey data analyses, we use gender identity as students reported at the time of the admission or on the survey. When reporting the results of the interviews, we use current self-reported gender identities.
People of Color (PoC vs. non-PoC)	In the survey data, People of Color refers to individuals who identify as African American, Black, Afro-Caribbean, American Indian or Alaskan Native, Asian American, Latinx, or Pacific Islander in institutional records. Non-PoC consists of White, non-Hispanic students. In interviews, students self-identified as PoC or non-PoC. In both data sources, PoC include only domestic students.
Socioeconomic status (SES Group 1 vs. SES Group 2)	The survey collected students' social class background based on their family's socioeconomic status when they were growing up. We categorized students into two groups: SES Group 1 includes students who reported low-income, working-class, or lower-middle class family background, while SES Group 2 includes students who grew up in middle-class, upper-middle class, or wealthy families.

[5] See the section on Survey design for description of the scales (p. 6 of this report).

First-generation (FG vs. CG)	First-generation college students are students who reported that neither parent(s)/guardian(s) have obtained a four-year degree in the US. Continuing generation (CG) students are those students who had at least one parent/guardian obtain a four-year degree in the US.

Qualitative analyses

For both the open-ended survey questions, a graduate student and undergraduate researcher analyzed data using a thematic approach (Braun & Clarke, 2006). To do this, they first read a small subset of responses to familiarize themselves with the data. They then generated initial codes and developed a codebook, searching the data for interesting features. After this, they returned to the data to search for themes, met to review these themes, discussed any discrepancies, and further refined the codebook. After resolving discrepancies, the graduate student then independently coded the remaining responses. To detect differences between groups in the survey responses, we also ran chi-square analyses. Because of time constraints, only the graduate student researcher coded the interviews, using and adapting the pre-existing codebook developed for the survey. In this report, we focus on quantitative survey results and utilize qualitative data to provide further insight and context into these findings.

RESULTS

SENSE OF BELONGING

Sense of Belonging to the Department

Overall, less than half of students (46.95%) fully agreed[6] that they felt a sense of belonging to their departments. Interviews with students supported this finding. For example, when asked "In general, do you feel welcomed and like you belong in the department?" one student replied, "Absolutely. Yes. It's a really friendly environment." Not all students expressed feeling that they belonged with such certainty, but generally shared a similar sentiment. For example, one student shared how she felt comfortable because of the friendliness and collegiality between different members of the community,

> Um, yeah, in general, I do feel like I'm welcome. […] I'm very comfortable with my grad student peers and um, the faculty are generally very friendly too. Like when I have had problems in the past, like maybe during a rotation… I've been able to talk to someone and then --I've been able to get support so that's been nice.

Students also shared how they felt that they belonged because they did not pick up on any signals that communicated otherwise. For example, another student shared "I haven't really had a problem with anybody. Everyone's super welcoming, um, students from all different backgrounds, professors from all different backgrounds. I've never felt like I was kind of ostracized."

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[6] We computed a belonging index score by creating a scale variable of the average of all 5-items for each participant. We then dichotomized responses into two categories based on their mean scores to the 6-point scale: do not fully agree (responses averaged between 1-4.49) and fully agree (4.5-6).

Yet, as the survey showed, some students did not experience such strong sense of belonging. One student shared how they actively resisted any signs that they did not belong, "I guess I've fought against [the feeling of not belonging] so much that like… I did belong. It's hard for me to think [about whether I belonged], cause … even if I've heard that I don't belong or that I shouldn't be there… I always like fought against that." When reflecting a bit more, the student mentioned how they felt like they pushed away feelings of not belonging, especially when witnessing differential treatment among faculty and other grad students,

> There are, like professors—and just how they interact with certain grad students and how they interact with me—I guess that's when I feel like I don't belong. But I've always kind of tried to fight against that or just that feeling.

At times, students found support from others in the PBSci community that helped to foster their sense of belonging. One student remarked how staff played a large role in facilitating their sense of community,

> When I first started graduate school, I didn't know a lot of things that were gonna like happen at once or challenges I was going to be facing. Like, [I had] really no one to go and seek advice from… so that was pretty hard at first. But then I was able to find a community within the campus through the STEM diversity office. So through the director and the coordinator, they really gave me a sense of belonging and uh, people to go to, to ask questions.

Despite more than half of students fully agreeing that they felt a sense of belonging, still 46.95% of students did not fully agree that they felt like belonged in their department (see Figure 1). In describing their experiences in the department, one student shared how geographical barriers prevented their department from building a sense of community, "So my department is split between [several] buildings and I never see the other students in my department. And I never see the other professors in my department… the community in our department is just broken." Another student spoke about how a lack of faculty support contributed to a low sense of belonging and lack of community in the department,

> Our department student organization already hosts several events each year and faculty participation is very low. It is difficult for graduate students to create community and some faculty make negative comments about students spending time on things other than their work.

For one student, their lack of belonging stemmed from a general sentiment of apathy towards community building,

> I felt so isolated and unwelcomed in the department that I thought about leaving the program… I later realized that it's not that most people are malicious, but that many people are apathetic towards any sense of community in the department.

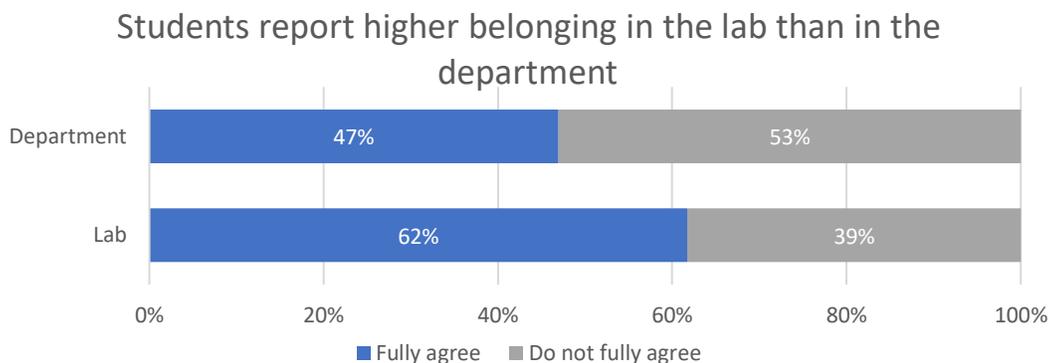**Group differences in department belonging.** While more than half of all participants felt like they did not fully belong to the department, students from historically marginalized groups (e.g., women, PoC, SES Group 1, FG students) generally reported lower belonging (see Table 4 in the appendix). However, chi-square analyses indicate there were no significant differences between groups (p's > .22).

Sense of Belonging to the Lab

Because department sizes vary drastically, it may be difficult for some students to find a sense of belonging to their departments compared to others. Therefore, we examined student belonging to their labs. Survey results indicate that more students fully agreed that they felt a sense of belonging to their lab (61.35%) compared to their department (46.95%), see Figure 2.

Figure 2.
Participants' overall sense of belonging to the department and to the lab.

Students report higher belonging in the lab than in the department

	Fully agree	Do not fully agree
Department	47%	53%
Lab	62%	39%

More students (61.35%) fully agreed that they felt a sense of belonging in their lab compared to those who did not (38.65%). During interviews, students spoke about their high belonging to their lab. One student shared how the sense of community they felt during a lab rotation helped them ultimately decide which lab to join,

> When I was rotating, I really enjoyed some of the people I worked with. And, um, like in my current lab, the reason why I joined wasn't really the research. It was more the people that I was working with and they were welcoming to me and I felt like a sense of community, even though we didn't really have a whole lot in common like at all… we grew really close.

When asked about their belonging in the lab, one student shared how collaborating with fellow students in their lab supported their sense of belonging,

> Um, yeah, especially with my lab mates, like when my lab mates and I get to work together on something, that's always like really fun. Cause you know, while we do similar stuff, at least for our lab group, um, it's not very often that we get to actually work together even though it's very similar stuff. Yeah. So, I really enjoy that. That's when I feel like, yeah, we're doing stuff.

Though some students have been able to identify instances in which they felt like they belonged, others still have yet to feel welcomed in their labs. One student admitted "Uh, I don't think I've like, felt really welcome or like really belonged yet. Yeah, it's, it's kind of at like a, it's like at an intermediate level." When asked to elaborate further on this statement, the student discussed how the feedback their advisor gave them made them doubt their belonging, "when the advisor] is like very critical without like, you know, a balance of both being constructive and being critical. That's when I start to feel like 'Oh, I don't know whether I should be here.'"

Group Differences in Lab Belonging. Chi-square analyses indicate one significant group difference. Students from SES Group 1 reported lower belonging to their lab than students from SES Group 2, χ^2 (1, 136) = 4.33, *p* = .037 (see Figure 3). For remaining comparisons, see Table 5.

Figure 3.
Participants' sense of belonging to the lab by SES.

Students from SES Group 1 report lower belonging to the lab than students from SES Group 2

	Fully agree	Do not fully agree
Overall	61%	39%
SES Group 1	49%	51%
SES Group 2	67%	33%
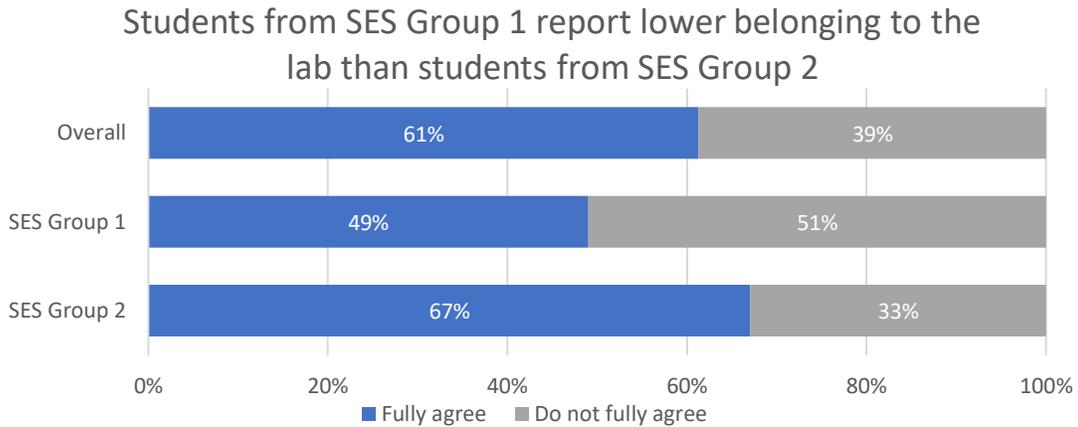
Although we did not find significant group differences related to race/ethnicity in students' overall sense of belonging to their lab, it is important to keep in mind that Students of Color were significantly more likely to have the SES Group 1 background than their White, non-Hispanic peers χ^2 (1, 117) = 5.03, *p* = .025. About one in two (45.00%) Students of Color grew up in SES Group 1 families compared to one in four (24.68%) White, non-Hispanic students.

Interview participants explicitly mentioned how they felt that their social identities shaped their experiences of belonging. For example, one Student of Color reflected on although their lab's composition has become more diverse, the social dynamics have not changed. They reflected that this could be because the members of their lab from the historically dominant group do not value the minority students' input and instead, seek to maintain their established dominant position,

> *The experience in the lab felt like a lot of my opinions were not welcomed or I felt like people just didn't want me to be there. I don't know if it's because the environment has been the same for years and when minority students in the lab entered, we changed that environment and they didn't like the fact that we're bringing something else to the table? I feel like they're trying their best for the environment and not change. They want it to be their way still. They don't want our input in the lab.*

Another Student of Color shared how they lack a sense of belonging because they felt that interactions or microaggressions from members of their lab conveyed underlying messages about their ability,

> *There have been many instances where peers from my lab have made me feel incompetent and dumb. I have gotten yelled at by postdocs and other senior graduate students. This has definitely affected my performance and ability to believe in myself as a competent graduate student. As a Student of Color, these situations have particularly made me feel like I don't have a sense of*

belonging. There have also been instances where faculty have made comments/microaggressions where my identity as a scientist has been questioned.

Students' sense of belonging was not only influenced by their racial/ethnic identity, but also by their social class backgrounds. A student from working-class background shared how they felt less valued in the lab compared to students from higher social class backgrounds,

There's just one graduate student in my advising group that is sort of a favorite of our advisor. He's also very well off, but he's gotten the large majority of the graduate funding in our department and a lot of, kind of… just preference for being able to take more time off for leisure or other hobbies… [And] in other ways given preference, in terms of like, in the project being given like a first and second authorship over someone else or something like that. I think […] that [the advisor] has some built in bias towards people that he identifies with more than others.

In this particular example, the student expresses a keen awareness that the student from a higher social class background received preferential treatment from their advisor and that this resulted from their shared social class background.

Factors that Influence Belonging

In the interviews, students shared some insight as to why they may or may not have felt a sense of belonging (summarized in Table 6).

Table 6
Factors that influence belonging

Theme	Example quote
Reasons why students do not feel like they belong	
Fear of rocking the boat	"I feel like in my department there's this culture of […] if you try to make things better, people like… don't like it. They just like the status quo. I think the status quo is kind of broken a little bit. I feel like things need to be changed but I never want to speak up or like, I feel like I can't be myself because people will not like that."
Not seeing others with similar identities in the department	"I am the only female grad student of my ethnicity, and there isn't a faculty member I can relate to. This often makes me feel alone and only exacerbates my impostor syndrome. Sometimes I feel like it is my duty to help improve diversity in my department because I am one of very few who are diverse, but I can never do enough and it never changes."
Feeling like the department did not value building social connections	"I wish that the department would say, 'let's get the cohort together at our next class meeting and let's just do some team building stuff.' I just wish they would have been more aware and listened to me or other students."
The intimidating nature of the qualifying exam	"It took me a long time to get through the qualifying exams. We get three attempts-- kind of failing those and barely holding onto those before making it through kind of made me feel like, 'What am I doing here?'"

Reasons why students feel like they belong

They have regular opportunities to socialize with peers and faculty	"There's a big picnic they have… I think it makes me closer to my peers and it also kind of humanizes the social circles that I hang out with. It makes it a little bit easier to interact with professors or the undergraduates once we've shared that sense of community."
	"During recruitment weekend all of us come together (from PBSci) and we learn from each other. I felt like all of the professors, all the students, they were just respectful. I felt very welcome. I felt comfortable right away."
They collaborate and get feedback from peers, faculty	"When my lab mates and I get to work together on something, that's always really fun because while we do similar stuff, at least for our lab group it's not very often that we get to actually work together. I really enjoy that."
They have opportunities to discuss and process national events together	"We had a couple instances of full-department, kind of like grief sessions, I would say, surrounding November 2016, and a few times since then with national politics. Those have been great to see the whole department come and sit in a room and express grief together. It's been really positive for community building."

Student belonging, especially at the graduate level, may largely depend on students' relationships with their professors. In the next section, students describe the relationships with faculty and with their own advisors.

RELATIONSHIPS WITH FACULTY AND ADVISORS

Influential Factors on Student' Relationships with Faculty

Analyses of both close- and open-ended survey items regarding relationships with faculty yielded generally positive findings**.** For example, the majority of students (93.54%) indicated that they could relate to or build a relationship with faculty members in their department. They also elaborated on why they found certain faculty more relatable or approachable (see Table 7).

Table 7

Factors that make faculty more relatable or approachable

Theme	Example quote(s)
Faculty are friendly	"The professors that I feel are relatable are all people who say hello to me in the hallway. They are people who check in with students, even if just passing by, and are genuinely interested in my well-being."
	"For me, openness is key. Professors who are friendly and down to earth are easy to begin to build a relationship with."
Faculty show that they care	"Approachability, a concern for my professional and personal well-being, being 'present' with me when we meet, treating me with respect rather than as an underling."

Theme	Example quote(s)
	"They care about me as a person and not just about me as someone to carry out their research plan"
	"They are understanding, genuine and they try to help instead of making you feel inadequate for not knowing something. They are approachable when I have questions."
Faculty make time for students	"It helps when the professors make themselves available in their offices and allow you to stop in to ask questions or advice. If they attend department events, that also provides time to establish relationships."
	"They are easy to talk to because they make it well known that you can come visit them whenever you have questions related to science. [...] Keeping office doors open and a willingness to communicate make building a relationship easy."
Faculty normalize struggle or challenge	"[When faculty] share stories of their careers with downfalls that one can relate to and that make current situations seem not as bad and 'survivable'
	"Openly social during departmental events, communicate willingly about their own experiences in science/graduate school, willingly listen and offer constructive feedback when approached"
	"This has happened when professors share their own experiences of going through grad school so you're aware that challenges you're facing aren't unique"
Faculty discuss topics outside of research, academia	"Friendly, offer advice, willing to talk about things other than lab work"
	"The professors seem open to conversations both about science/work and things outside work. Meeting/talking with professors outside of meetings or class (social events, etc.). Common interests"
Faculty share similar identities or life experiences	"The recent hiring of female professors in [the department] has significantly improved my research network and collaborations. My primary advisor is also female... and I find that I am much more confident and comfortable sharing research results with my primary advisor."
	"I feel that professors that are also mothers can understand the unique challenges that come with juggling childcare and research."
	"They came from another country to the US for college/PhD. English is their second language..."
Faculty value diversity, equity, and inclusion	"The professors that I feel most comfortable with are the ones that have signs outside of their offices/labs advocating safe-space, diversity, and inclusion."
	"A demonstrated passion for increasing diversity and inclusivity. Marked empathy. The drive to reach out to graduate students and offer support. Past positive relationships with other grad students or postdocs."

Though most students felt like they could relate to faculty, it is important to underscore that a few students (6.46%) still did not find any faculty or professors relatable.

Interviews helped to clarify why some students may have had trouble connecting with faculty. One student mentioned witnessing differential treatment,

> There are certainly individual faculty who I know will treat students differently dependent on their identity. There is one faculty member who has a reputation for treating [their] male graduate students much better than [their] female graduate students… There's another faculty member who has a reputation for treating [their] graduate students [without children] better than [their] graduate students [with children] in subtle ways…not in sort of massive discriminatory ways, but in subtle ways.

Another student talked about how being viewed only as a worker, rather than a person, could also contribute to difficulty in establishing relationships,

> You have to mentor the person, not only the worker. I think it gets really toxic when that is neglected and when, especially, in the grad student's shoes, the mentor has a lot more power over the grad student because the mentors control the pay and whether or not the grad student graduates. Having that type of dynamic just puts the grad student in a very vulnerable position.

Students' relationships with faculty and advisors play an important role in their graduate student experience. These relationships may implicitly communicate to students whether their advisors believe in their ability to succeed, which is covered in the next section.

Perceptions of Advisors' Beliefs about Students

Overall, 64.79% of participants fully agreed[7] that their advisors believed in them while 35.32% did not. For example, one student shared how discussions with their advisor affirmed their place in the program, "My thesis advisor helped me along the way… and assured me that I belong here. I can also be a scientist. And now I feel super confident being here in my graduate program." Another student shared how they had a better sense of their performance because their advisor regularly gave them feedback "Since I've started working with her, she's been pretty good about giving me like frank performance analyses, which I really appreciate." Here, the student expresses how having conversations with their advisor about their work helped to take the guesswork out of what their advisor thought of them.

Without regular meetings, the lack of interactions with advisors may evoke feelings of worthlessness for students, as one student mentioned in an interview, "If your advisor never checks in on you, then you just feel like you don't matter." Yet, just meeting with students is not enough. The type of feedback advisors give to students is also critical in shaping students' perceptions; one student shared

> I think he's disappointed in me all the time. We have weekly meetings where we talk and a lot of it is him telling me what I did wrong and not a lot of like advice on how to improve … So, at the moment, I'm just stressed out because I'm like, "Oh my gosh, am I an idiot? Am I really like doing everything wrong?" I don't know what to do. I only see my lack of progress. I don't know if maybe it's my advisor being too harsh or maybe am I really not improving?

In describing their relationships with their advisors, some students receiving mixed messages. For example, an interview participant shared that while they receive generally receive positive feedback from their advisor, this is not always consistent,

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[7] We computed an advisor index score by creating a mean variable of all 8-items for each participant. We then dichotomized responses into two categories based on their mean scores: do not fully agree (responses averaged between 1-4.49) and fully agree (4.5-6).
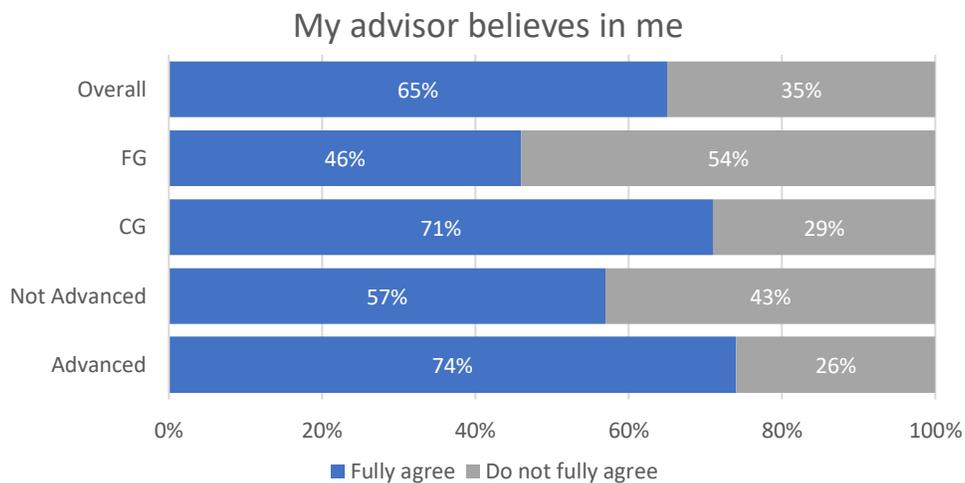
> I would say, you know, the only place that [they] struggle is… with that consistency of, uh, always being supportive because it seems like a very common theme that when our faculty members get pushed, like in really stressful positions, they, you know, will kind of forget to be kind to people. They'll forget to look out for the graduate students. They'll, you know, whatever, drop various different things because they're, you know, so stressed about something else.

Therefore, whether students felt like their advisors believed in them does not fall into an either-or category. This can vary based on situational factors (e.g., the advisor's workload).

        Group differences in students' perceptions of advisors' beliefs. Chi-square analyses revealed two significant group differences. First, compared to CG students, FG students were less likely to feel like their advisor believed in them, $\chi^2 (1, 135) = 4.15$, $p = .04$. Additionally, compared to advanced students, students who had not advanced to candidacy were less likely to feel like their advisor believed in them, $\chi^2 (1, 135) = 4.06$, $p = .04$. See Figure 4 for percentages and Table 6 in the appendix for the remaining group comparisons.

Figure 4
Participants beliefs of whether their advisors believed in them by college generation status and candidacy status.

My advisor believes in me

Group	Fully agree	Do not fully agree
Overall	65%	35%
FG	46%	54%
CG	71%	29%
Not Advanced	57%	43%
Advanced	74%	26%

There may be many factors (e.g., passing the qualifying exam, which can seem intimidating and intended to "weed students out"[8]) that contribute to why advanced students are more likely to feel like their advisor believes in them. However, for one student, it was because advancing to candidacy was the first time they received positive feedback from their advisors,

> Right after the qualifying exams I guess like my, like three advisors emailed me and they were like, "Oh, congratulations on passing," like "we're so happy." And I guess that was kind of like when I realized that they like were on my side and did want me to succeed. Whereas I guess before that I was kinda like, "Oh, I don't really know like what they are thinking."

As these quotes allude to, advisors' perceptions of their students have important implications for students' academic engagement, feelings of burnout, and sense of belonging. The author unpacks these relationships in the next section.
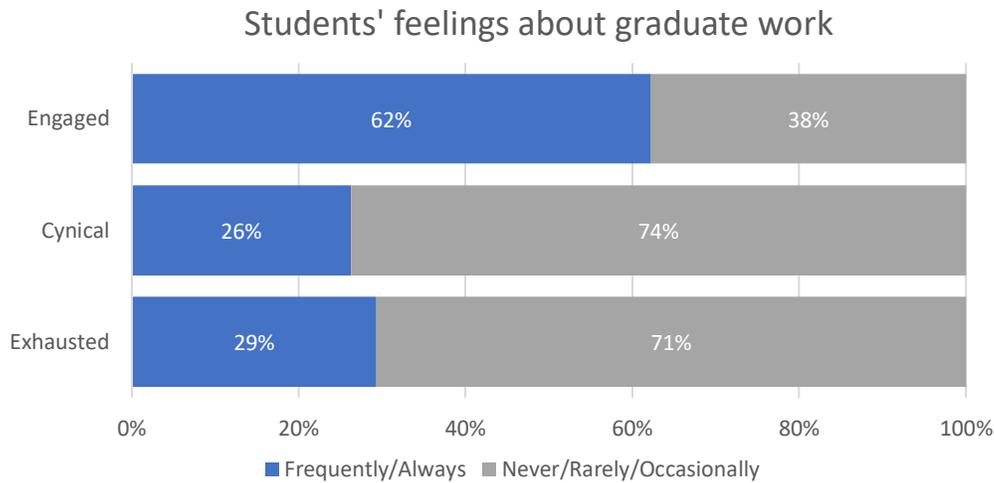
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[8] Multiple students mentioned this theme during interviews.

ACADEMIC ENGAGEMENT & BURNOUT

Generally, the majority of students had positive feelings about their graduate work. For example, almost 2 in 3 students felt frequently to always engaged with their work. Still, between a quarter to about 30% of students felt cynical and exhausted by their studies (see Figure 5).

Figure 5.
Participants' feelings of engagement, cynicism, and exhaustion about their graduate studies.

Students' feelings about graduate work

	Frequently/Always	Never/Rarely/Occasionally
Engaged	62%	38%
Cynical	26%	74%
Exhausted	29%	71%

Note: For each subscale, we dichotomized students' responses to into two categories based on their mean scores for each subscale: Never/rarely/occasionally (1-3.49) and frequently/always (3.5-5).

In an interview, one advanced student shared that while they enjoy the work that they do, the amount of time spent working may not be feasible long-term,

> I tend to work between 60 and 80 hours a week and that's exhausting. I love it, you know, but it is exhausting and it's very hard for me to then give myself permission to take time off afterwards… And I just— that's not sustainable.

The same student shared how although the amount of time they spent working each week could be tiresome, it was not out of the norm,

> During the summer I work 40 hours a week… During the school year… 50 hours a week is a light week, and 60, 70-pushing-80 is very, very normal… and I'm not really the exception to the rule.

As the student reflected more on the norms of managing a high workload in their department, they shared that these expectations may be subtly communicated through the work habits of faculty,

> Um, part of that I think comes from example. The faculty are no better in a lot of respects. You know, a lot of them don't have good work life balance either. And so, they expect their students not to have good work life balance and don't recognize how that is hurting them and actually hurting their ability to be productive. And then also skewing their perception of what their students should be doing and putting pressure on their students to work as much as they do…

Another student mentioned faculty's lack of a work-life balance, particularly how it made them feel like they were only valued for their labor,

> There was a very strong environment of like… Grad students are just like data pumping machines. And so like, a lot of people would like, work in the lab for weekends and just like, continuously without breaks. And we would have like lab meetings during like holidays. So, um, it really made me question like… Is this just something that I need to get used to? Am I just like not good enough for this type of thing? So that, that was really hard for me.

Group differences in academic engagement and burnout. There were no significant group differences in students' sense of academic engagement or cynicism (see Tables 7-8 in appendix B). There was one significant group difference in students' feelings of exhaustion. Students who had advanced to candidacy (36.49%) felt more exhausted than students who had not advanced to candidacy (20.63%), χ^2 (1, 137) = 4.14, p = .04 (see Table 9 in appendix B for all group comparisons). These are very important findings that a strong sense of academic engagement and rare/absent cynicism were similarly prevalent among students from historically marginalized backgrounds and their peers.

Correlations between Belonging, Perceptions of Advisors' Beliefs, and Academic Engagement

Bivariate correlations indicate the associations between students' belonging, perceptions of advisors' beliefs, and feelings of academic engagement and burnout. For all students, a higher sense of belonging to both their department and their lab was related to stronger perceptions of advisor support, higher engagement, and lower exhaustion and cynicism (see Table 10).

Table 10

Correlations between belonging, perceptions of advisors' beliefs, engagement, exhaustion, and cynicism for all participants

	1	2	3	4	5	6
1. Belonging to the department	–	.71**	.45**	.39**	-.36**	-.40**
2. Belonging to the lab	–	–	.56**	.37**	-.45**	-.69**
3. Perceptions of advisor beliefs	–	–	–	.38**	-.34**	-.36**
4. Engagement	–	–	–	–	-.45**	-.59**
5. Exhaustion	–	–	–	–	–	.61**
6. Cynicism	–	–	–	–	–	–

The positive associations between measures of academic engagement and burnout suggest that students' sense of belonging and perceptions of advisors' beliefs may shape their graduate student experiences. To increase feelings of belonging and improve relationships with advisors, students offered many recommendations to the division, which are detailed in the following section.

STUDENT RECOMMENDATIONS

In both the survey and in the interviews, students shared recommendations on how the division can improve the graduate student experience by responding to two open-ended items:

1. What specific recommendations do you have **for faculty** to improve the climate to better support diverse graduate students in their **academic/professional success**? …in their **social, mental, or personal wellbeing?**
2. What specific recommendations do you have **for your department** to improve the climate or to better support graduate students with diverse backgrounds in their **academic, social, or personal wellbeing?**

In the survey, 116 students provided recommendations for faculty and 96 made suggestions for the department. Because of overlapping themes, the author combined students' recommendations for each of the questions summarized them (see Table 11) and elaborated on each below.

Table 11.
Major themes from students' recommendations to faculty and the departments

Students would like faculty and departments to…

1. Provide mandatory training/workshops for faculty
2. Hire more diverse faculty, staff, and students
3. Make and uphold a commitment to diversity, equity, and inclusion
4. Increase avenues for graduate student feedback
5. Provide more opportunities to build community among students and faculty

Provide mandatory training/workshops for faculty

In the open-ended survey items, students explicitly mentioned that faculty should receive mentor training to better support their students. Recognizing that faculty often do not receive any training on how to manage students, one student shared in an interview,

> I think [training] would be a good thing to have… some type of general management and personal management course, some kind of workshops or something-- just like mandated for it.

Students shared various training topics that they would like faculty to learn, summarized in Table 12.

Table 12.
Faculty topics that students mentioned during interviews and open-ended survey responses.

Potential Faculty Training Topics & Learning Outcomes

How to Support Students from Historically Marginalized Backgrounds
- Do not make assumptions about students' experiences, their backgrounds, or previous education
- Learn how to listen to and hold space for students to talk about their experiences
- Be an advocate for your student—do not passively standby as students experience microaggressions—learn how to respond to them and ensure your students have a safe and comfortable learning environment
- Be aware of and connect students with various resources on campus (including mental health)
- Be aware of and support students in applying to various fellowships, organizations, or associations dedicated for students from historically marginalized backgrounds (e.g., Ford Foundation)

How to Set Clear Expectations
- Discuss time expected in lab and during breaks (including the frequency of both individual and group meetings)
- Establish clear communication expectations (e.g., preferred methods to communicate such as email, Slack, text; appropriate time windows to communicate; expectations on response times)
- Communicate expectations for checking in about research progress, lab maintenance (e.g., maintaining and cleaning the space, mentoring undergraduates, organizing events)
- Outline preferences for providing and receiving feedback
- Check in about academic progress and career goals

How to Establish Positive Lab Dynamics
- Treat students equally (be aware of differential treatment and uneven distribution of labor)
- Establish and uphold community agreements about respectful interactions in the lab space
- Host lab retreats and community building events
- Address conflict between students and actively facilitate a solution

How to Support Graduate Students as People
- Ensure students' personal growth and learning is a priority
- Give students regular, individual check-ins (students expressed frustration with the lack of time or focus their advisor gave them)
- Check-in about well-being and mental health, not just academic progress
- Encourage a healthy work/life balance
- Provide space to talk about impostor syndrome, normalize struggle

Aside from suggesting that the departments offer training to current faculty, students also made recommendations for improving the recruitment and retention of historically marginalized students in the department.

Hire more diverse faculty/staff & admit students from diverse backgrounds

Students recommended that the division hire more diverse faculty, hire a full-time staff person for administrative support, and admit more students from diverse backgrounds. Students overwhelmingly mentioned that the department should hire more diverse faculty, citing it as the "the most impactful action the department can take," and describing the downstream effects of how "…this will help recruit diverse students as well." Yet beyond hiring faculty from diverse backgrounds, some students underscored the importance of hiring faculty that are committed to diversity. For example, one student suggested, "[hire] faculty that have shown they will put effort into improving the department culture regarding diversity, equity and inclusion." Aside from more diverse faculty, students also recommended that departments invite "more diverse seminar speakers."

Students also pointed to the importance of hiring full-time staff positions for each department so that they could "have adequate administrative support for students!" and provide holistic support,

> I also think our graduate advisor is essential to grad student wellbeing, particularly those facing the associated challenges with being minoritized, so it'd be a great boost to grad student quality of life for the grad advisor to be a full-time position.

Other students mentioned how one way to retain graduate advisors is to increase their pay, given that they have "seen the turnover in this position due to the lower pay, caus[ing] chaos among grad students."

In the surveys and interviews, students expressed the importance of recruiting and retaining people from diverse backgrounds not just among faculty and staff, but also at the graduate and undergraduate level. Multiple students recommended that departments and faculty "Seek out a more

diverse graduate student body. It'd be nice to have more people of different backgrounds," "support organizations like WiSE [Women in Science and Engineering], continue with programs to enroll more diverse sets of graduate students," and "support more diverse undergraduate students in their research."

Make a commitment & concerted effort to support a diverse community

Aside from suggesting that the department recruit and retain more diverse members to the community, students also underscored the need to actively foster diversity, equity, and inclusion (see Table 13).

Table 13

Student recommendations on how to support a diverse community

Theme	Example quote(s)
Collaboratively create, enforce, and uphold community guidelines	"Maybe a short announcement or something about some workplace conduct that would be considered unacceptable. I didn't encounter problems with many people, but there were a few somewhat extreme cases."
	"Make action items after diversity related forum/discussion. Force faculty to pick something to do."
Sponsor identity-based workshops, events, and social groups	"Have diversity workshops that cover not just ethnic diversity but also diversity in mental health, career goals, etc. would be helpful as well"
	"[Provide] networking events for women and students of color with working positions (i.e., non-academic positions). [Provide more] frequent microaggressions workshops for the department."
	"Provid[e] spaces and funding for student groups of students with shared identities."
Provide financial support or funding opportunities to students experiencing economic insecurity	"Santa Cruz is an extremely expensive city to live in. That alone prevents many diverse groups from being able to attend graduate school here. From a division level, getting paid a living wage is very important. From faculty, being transparent about their funding ability so that students can make informed decisions when choosing an advisor, etc., is important (e.g., If a faculty cannot afford to pay a student over the summer, some students cannot make that work and should know that off the bat)."
Destigmatize and normalize discussions around mental health (and differently abled learners)	"Recognize that mental health is a huge issue for grad students, and even more so for diverse grad students, and be accommodating. The rates of depression and anxiety in grad students are way above the national average."

Students also recommended that departments make a commitment to diversity, equity, and inclusion (DEI) by: writing and posting department diversity statements on their website (explicitly mentioning how these values will be used to assess potential job hires); by preventing an unequal distribution of labor (as DEI service work often falls disproportionately on students and faculty of color); and by providing recognition and compensation to folks who actively engage in DEI efforts (including some form of documentation or punishment for those who violate community guidelines). For some students, this desire to hold faculty accountable for their actions resulted from feelings of frustration,

Current methods of getting faculty on board and to understand the issues aren't' working. Graduate students who haven't experienced problems related to diversity, equity, and inclusion often are very outspoken about the issues not being real, and don't listen to those who have had the issues. They say things that indirectly put down and silence those who have had problems. The department needs better communication, recruitment of people who have experienced and/or are sympathetic to the problems and want to make changes.

Increase avenues for graduate student feedback

In both the surveys and the interviews, many students called attention to the importance of soliciting graduate students' feedback throughout the year. This could occur through anonymous surveys, "A survey like this for just our department would be great," or through student-only townhalls. Some students asked leadership and faculty to have frequent and open "meetings with the graduate students about needed changes or issues facing currently graduate students" by "invit[ing] graduate students to faculty meetings" or by appointing a graduate student representative or "a confidential liaison for discussing issues with peers or faculty without impending harm for the graduate student..."

Students not only wanted more opportunities to discuss their concerns, needs, and experiences in the department, but also to participate more in the faculty hiring process. Students often remarked on how faculty should "listen to the grads when they have red flags about potential faculty hires."

However, beyond providing a space for students to air their concerns, departments must avoid performative and shallow attempts to create more inclusive spaces and follow these discussions with direct action. One student highlighted the need for action, "I think town-hall style discussions are great and we have been doing them. We should continue. But at a certain point we need to move towards actions instead of constant discussions." A student offered one simple step departments could take, "Make action items after diversity related forum/discussion [and] force faculty to pick something to do."

Provide more opportunities students to connect with others

In their recommendations, many students asked that their departments provide more opportunities to socialize with both their peers and with faculty. Example quotes are provided in Table 14 below.

Table 14

Student recommendations for social events

Students would like opportunities for…	Example quote(s)
…students with shared identities to meet and get to know each other	"More meetings, more social things like beer hour or lab outings for lunch/dinner. STEM Div is awesome and can help many of the Latinx student population, but they need more money and help to expand that to other communities that are underrepresented."
	"A space for students with a shared identity would be great, even if it's just for an allotted amount of time."
…students to meet and get to know other students	"Provide more opportunities to meet other graduate students…"
	"…provide the means to foster community and wellbeing (e.g., dedicated lounge room for students to socialize or retreat to when they need some time/space from their lab/office)."

Students would like opportunities for…	Example quote(s)
…students to meet and get to know other students and faculty	"More department events maybe help people feel included overall and allow people to make friends they typically wouldn't meet in day to day life on campus." "Cultivating a relationship [with faculty] that is not solely focused on work." "Have more social events that aren't based around drinking. Give the space for students to organize events. Many students don't want to organize anything because they feel that the professors will judge them for getting involved in 'departmental politics' or 'not working." "I would like to see more departmental functions that are inclusive of everyone. Regular BBQs, multi-lab outings, etc. Let's build connections and community throughout the department rather than creating more silos." "More purely social events would go a long way to removing the feeling of isolation many students have."

These opportunities to build relationships with peers, faculty, and their broader communities may help to bolster students' sense of belonging not only to their labs, but to their departments and the greater campus community. This increased belonging could have many positive downstream consequences for students and therefore should be explored by departments and the division.

This report provides a brief snapshot into students' sense of belonging, their perceptions of their relationships with faculty and advisors, and their feelings of academic engagement and burnout. Based on the results of this program evaluation, the research team concluded that the PBSci Division can do better for its graduate students by increasing student belonging, improving their relationships with faculty and advisors, and fostering a climate where students feel more academically engaged and less burnt out. We revisit the three research questions used to evaluate doctoral students' experiences in the PBSci division, summarizing results from the assessment below.

RQ1: Do students feel a sense of belonging within their departments? Within their labs? Do students from historically marginalized backgrounds (e.g., first-generation, working-class, Students of Color) report different perceptions of belonging compared to their peers?

The survey results indicated that just under half of all students (46.95%) fully agreed that they felt a sense of belonging to their departments. This feeling of belonging to their departments did not differ between students from historically marginalized backgrounds and their peers. Unsurprisingly, more students (61.35%) fully agreed that they felt a sense of belonging to their labs or research groups. Although this represents more than half of students, it is concerning that nearly 1 in 3 students do not feel a sense of belonging to their research labs. In terms of group differences, students from SES Group 1 reported lower belonging than students from SES Group 2. This is consistent with previous work that has documented how students from lower social class backgrounds report lower sense of belonging in graduate school (Ostrove et al., 2011).

Given that a key element of whether graduate students leave or complete their graduate programs depends on to extent to which they felt a part of their graduate community (Lovitts, 2001), efforts should seek to bolster students' sense of fit within their respective departments and labs. Researchers and scholars have previously detailed the importance of fostering meaningful relationships between peers and faculty for doctoral students, who may suffer from isolation and benefit from various networks of support throughout their graduate career (Ali & Kohun, 2006; Davis & Parker, 1997; Wilkins-Yel et al., 2019). Most recently, and perhaps, most relevantly, Stachl and Baranger (2020) completed a study within the Department of Chemistry at another R1 university that examined various factors that influenced doctoral students' sense of belonging. Similar to the PBSci needs assessment, a department brainstorming session resulted in many feasible and practical strategies for fostering student belonging, including hosting social events, hosting seminars that normalize struggle or failure, and implementing mandatory meetings between advisors and students after passing their qualifying exams. As PBSci administrators, department chairs, faculty, and staff begin developing initiatives to facilitate student belonging, they should take into consideration students' specific recommendations on how to improve their sense of community at both the department and lab level.

RQ2: Are students able to build positive relationships with faculty? Do students perceive that their advisors believe in them? Do students from historically-marginalized backgrounds differ in these perceptions from their peers?

Survey results also suggest that students generally have positive relationships with faculty and their research advisors. They identified many positive qualities of faculty members that made faculty appear more relatable or approachable, including being friendly, showing that faculty care about students, making time for students, normalizing struggle, discussing topics outside of research, sharing similar identities or life experiences, and valuing diversity, equity and inclusion. Interviews with students

revealed factors that prohibited students from connecting with faculty, including witnessing differential treatment and being treated only as a worker (rather than a person).

Though the majority of students agreed that their advisors believed in them, approximately 1 in 3 students felt that their advisors did not. This is essential to address, given the importance of the advisor-advisee relationship on students' feelings of belonging, wellbeing, productivity, and retention (see Curtin et al., 2013; Denis et al., 2018; Girves & Wemmerus, 1988; Schlosser et al., 2003; Sverdlik et al., 2018). Students shared that various interactions may have influenced these beliefs (e.g., lack of interactions, lack of feedback, lack of clear expectations). This may have detrimental effects on students attrition, as prior work has documented how students who dropped out of their graduate programs felt that their advisors were not invested in them as people or in their research (Lovitts, 2001). Therefore, not only should departments focus on students' sense of belonging, they should also pay considerable attention to students' relationships with faculty and primary advisors. The division and/or its departments may seek to develop workshops for faculty on how to foster positive working relationships with their advisees.

RQ3: How prevalent are feelings of academic engagement and burnout? Do students from historically-marginalized groups report different feelings from their peers?

Students reported generally positive perceptions. Specifically, 62% of students frequently or always felt engaged in their work while 29% frequently or always felt exhausted. Most importantly, a strong sense of academic engagement and relatively infrequent cynicism or exhaustion were similarly prevalent among students from historically marginalized backgrounds and their peers. Of note, more students advanced to candidacy felt exhausted than students in their first stages of the program. This could be due to accumulation of exhaustion due to long hours spent in the lab (as mentioned in open-ended responses).

Conclusion

Because a higher sense of belonging is associated with stronger feelings of faculty support, higher academic engagement and lower exhaustion and cynicism, efforts to increase student belonging should be explored. However, the division should work to improve belonging in addition to, not instead of, addressing any particular issues with diversity, equity, and inclusion that may harm students from historically marginalized backgrounds. Students offered a wealth of suggestions to combat some of the issues with belonging, with building relationships with faculty, and with their feelings of academic engagement and burnout. Because of their interconnectedness, improvement in any of these components may improve the overall quality of the program. The division should meaningfully incorporate these suggestions into their brainstorming and strategy sessions on how to improve graduate students' experiences in PBSci.

To enact meaningful and relevant change to support the various student populations in PBSci, it is especially important for the division to continually engage with and solicit feedback from its graduate students. While this report offers a series of recommendations provided by PBSci graduate students in Summer 2019, since then, many other important issues have gained prominence at the university (e.g., the Cost of Living Allowance campaign), national (e.g., Black Lives Matter movement), and global (e.g., COVID-19 pandemic) levels. As requested by the students, PBSci administrators, department chairs, faculty, and staff should consistently provide opportunities for students to express their needs, concerns, and wishes so that they can adequately receive holistic support. Though supporting students in their social, academic, and professional wellbeing may lead to better teaching and research productivity for the university overall, the author of this report seeks to appeal to those in positions of power to support and advocate for students because it also enhances students' quality of life. Viewing graduate students in relation to their outputs as researchers and workers may inadvertently place

efforts to support their wellbeing as a "means to an end," rather than a valued goal in and of itself. Doing so may cultivate a community that truly embodies the values of the university and its commitment to serve its students.

Project Limitations & Strengths

The PBSci Graduate Student Needs Assessment had both its limitations and strengths regarding its design, timeline, and research team. Because some of the project's limitations are also some of its strengths, they are discussed together below.

Design of the study

Originally, the two graduate student researchers had been asked to run focus groups with PBSci graduate students to learn more about their experiences and perceptions of the climate in PBSci. Focus groups would have allowed the interviewer to serve as a moderator and glean insights and data that emerged from group interaction (Morgan, 1997). Focus groups, in this way, may have provided more in-depth understanding of students' experiences (e.g., allowing participants to build off of each other, corroborate experiences, examine contradictions or differing perspectives). However, after discussion with key stakeholders, the graduate student researchers ultimately decided that focus groups may not be feasible given the timeframe in which the project was to be complete. First, focus groups take longer to conduct, transcribe, and analyze. Second, it may have been difficult to foster a comfortable space where students could openly share and discuss their specific challenges or experiences with sensitive topics among their peers.[9] Focus groups, in this context, may not have afforded participants the same levels of privacy and protection as other methods. Third, focus groups do not allow to estimate the prevalence of negative experiences of climate and low sense of belonging that make the evaluation of the program more comprehensive and conclusive.

One strength of the project, then, included its mixed-methods approach. In utilizing both surveys and semi-structured interviews, the project allowed for more representative and nuanced understanding of the different experiences of graduate students. Since the research team administered the survey to all PBSci graduate students, the team had a better opportunity to collect information from as many participants as possible. Using pre-established scales found in psychology and education research allowed the research team to examine elements previously demonstrated to be important to students' academic experiences. The survey also had many protections of student privacy in place. For example, it was administered and maintained by IRAPS's survey analyst and was de-identified (e.g., names, departments, demographic identifiers redacted) before the graduate student researchers had access to analyze data. Collaborating with the survey analyst also allowed the team to generate a unique survey link for each participant, allowing students to participate and complete the survey at their own pace, rather than completing it in one sitting. The quantitative data allowed the research team to examine overall patterns and group differences among different constructs. Additionally, the open-ended survey items and interviews allowed for a more holistic view into students' experiences that could not be captured in close-ended items. The interviews complemented the quantitative data and had the advantage of privacy for participants as they disclosed personal or sensitive information.

Timeline

The 3-month period in which we completed the PBSci Needs Assessment had both its drawbacks and benefits. Because of internal deadlines, the research team sought to design, develop, and run the study (including gaining IRB approval) as well as analyze results and write up a report in one summer.

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[9] Though not included in this report, survey and interviews also explored students' experiences and/or perceptions of identity-based challenges, discrimination, and sexual harassment/assault.

One limitation for this data collection period is that graduate students may be more likely to travel, conduct field research, or participate in internships in the summer, therefore, they may not be as likely to participate or be available for the study. Additionally, data collection occurred at a transitional time (late summer) where many graduate students may have just completed their degrees and moved on. While this may not have impacted their ability to participate in the survey, it may have affected their motivation or their ability to participate in an interview. At the same time, students may also have had more time to participate in the study during a time with fewer demands, compared to the academic school year, a benefit of conducting the assessment during the summer. The short timeline also prevented the research team to explore more in-depth methods (e.g. focus groups, observations), or conduct member checks of the themes gleaned from the interviews.

The research team and stakeholders
        The student input in all of the research aspects of this study primarily came from two doctoral students in Social Sciences (Psychology). Their positionalities may have served as both a limitation and a strength. As a White woman and an Asian American woman from middle-class backgrounds, the graduate student researchers do not have in common the same identities of all interview participants, and therefore may not have insight into their experiences. Additionally, graduate students in a non-STEM discipline, they do not share the "insider" status to the STEM fields that could strengthen the project's design and development. However, it may have been easier for them to be objective than for someone who is a STEM student. Being graduate students surveying and interviewing other graduate students likely gave them a shared feeling of mutual understanding and allowed participants to share more freely and comfortably their experiences. Moreover, their experience as current doctoral students may have given the research team additional insights and sensitivity to understanding student experiences.
        The PBSci Needs Assessment was supported by, and possible because of, a collaboration among stakeholders form multiple divisions (PBSci, Student Success, Graduate Studies, IRAPS). One obvious strength of this collaboration is the different skills and roles each member contributes. For example, the graduate student researchers received extensive support from an experienced researcher in IRAPS with expertise in survey design, administration, and statistical analysis, and most importantly in assessing graduate programs and diversity, equity and inclusion in higher education settings. Senior leadership also provided detailed feedback on study materials so that the results could yield actionable steps, on their part, to support graduate students in their academic success. During the initial stages of the study, they provided support and resources for the project at all levels. Since the end of the study, they have met multiple times with different university stakeholders and leaders (e.g., deans, department chairs) to discuss and develop programs based on the PBSci Needs Assessment. In fact, PBSci leadership will begin rolling out these initiatives in Fall 2020.

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Appendix A
Belonging to the Department

Table 4
Frequencies and chi-square results for participants' sense of belonging to the department (index).

	Fully agree		Do not fully agree		(*df*, n)	χ²	*p*
Group	Number	Percent	Number	Percent			
All students	**67**	**46.95%**	**76**	**53.05%**			
Gender					(1, 137)	.65	.42
Men	40	51.95%	37	48.05%			
Women	27	45.00%	33	55.00%			
Race/Ethnicity					(1, 116)	.08	.78
PoC	18	43.90%	23	56.10%			
Non-PoC	35	46.67%	40	53.33%			
SES					(1, 137)	1.40	.22
SES Group 1	20	39.22%	31	60.78%			
SES Group 2	43	50.00%	43	50.00%			
College generation status					(1, 137)	1.41	.24
FG	21	39.62%	32	60.38%			
CG	42	50.00%	42	50.00%			
Candidacy status					(1, 138)	.21	.65
Not advanced	31	49.21%	32	50.79%			
Advanced	34	45.33%	41	54.67%			
Nationality					(1, 143)	1.02	.31
Domestic	53	44.92%	65	55.08%			
International	14	56.00%	11	44.00%			

Note: We computed a belonging index score for individual respondents by calculating a mean of their responses on all 5-items. We then dichotomized responses into two categories based on their mean scores on the 6-point scale: do not fully agree (means between 1-4.49) and fully agree (4.5-6).

Belonging to the Lab

Table 5.

Frequencies and chi-square results for participants' sense of belonging to the lab (index).

Group	Fully agree Number	Fully agree Percent	Do not fully agree Number	Do not fully agree Percent	(*df*, n)	χ²	*p*
All students	**87**	**61.35%**	**55**	**38.65%**			
Gender					(1, 135)	2.22	.14
Men	52	68.42%	24	31.58%			
Women	33	55.93%	26	44.07%			
Race/Ethnicity					(1, 114)	1.11	.29
PoC	21	53.85%	18	46.15%			
Non-PoC	48	64.00%	27	36.00%			
SES					(1, 136)	4.33	.04
SES Group 1	25	49.02%	26	50.98%			
SES Group 2	57	67.06%	28	32.94%			
College generation status					(1, 135)	3.26	.07
FG	27	51.92%	25	48.08%			
CG	56	67.47%	27	32.53%			
Candidacy status					(1, 135)	.29	.59
Not advanced	36	59.02%	25	40.98%			
Advanced	47	63.51%	27	36.49%			
Nationality					(1, 141)	.01	.91
Domestic	71	61.21%	45	38.79%			
International	15	60.00%	10	40.00%			

Note: We followed the steps to compute the belonging index as described in Table 4.

Appendix C
Perceptions of Advisor's Beliefs

Table 6.
Frequencies and chi-square results for participants' score on the advisor index

Group	Fully agree		Do not fully agree		(*df*, n)	χ^2	*p*
	Number	Percent	Number	Percent			
All students	89	64.79%	48	35.21%			
Gender					(1, 133)	.96	.86
Men	48	63.87%	27	36.13%			
Women	38	37.50%	20	34.48%			
Race/Ethnicity					(1, 113)	.66	.42
PoC	24	63.16%	14	36.8%			
Non-PoC	53	70.67%	22	29.33%			
SES					(1, 135)	1.91	.18
SES Group 1	29	58.00%	21	42.00%			
SES Group 2	59	69.41%	26	30.59%			
Nationality					(1, 137)	1.99	.16
Domestic	77	67.54%	37	32.46%			
International	12	52.17%	11	47.83%			

Appendix D
Feelings of Academic Engagement, Cynicism, and Exhaustion

Table 7.
Frequencies and chi-square results for participants' feelings of academic engagement (index).

	Frequently/Always		Never/Occasionally		(df, n)	χ^2	p
Group	Number	Percent	Number	Percent			
All students	**55**	**38.65%**	**87**	**61.35%**			
Gender					(1, 135)	.26	.61
Men	47	62.67%	28	37.33%			
Women	35	58.33%	25	41.67%			
Race/Ethnicity					(1, 115)	1.43	.23
PoC	28	70.00%	12	30.00%			
Non-PoC	44	58.67%	21	41.33%			
SES					(1, 136)	.03	.86
SES Group 1	32	62.75%	19	37.25%			
SES Group 2	52	61.18%	33	38.82%			
College generation status					(1, 138)	.97	.33
FG	36	66.67%	18	33.33%			
CG	49	58.33%	35	41.67%			
Candidacy status					(1, 137)	.46	.50
Not advanced	41	65.08%	22	34.92%			
Advanced	44	59.46%	30	40.54%			
Nationality					(1, 141)	.09	.76
Domestic	73	61.86%	45	38.14%			
International	15	65.22%	8	34.78%			

Table 8.
Frequencies and chi-square results for participants' feelings of cynicism towards their work (index).

	Frequently/Always		Never/Occasionally		(df, n)	χ^2	p
Group	Number	Percent	Number	Percent			
All students	**37**	**26.30%**	**103**	**73.70%**			
Gender					(1, 134)	.91	.34
Men	22	29.33%	53	70.67%			
Women	13	22.03%	46	77.97%			
Race/Ethnicity					(1, 116)	.74	.39
PoC	8	19.51%	33	80.49%			
Non-PoC	20	26.67%	55	73.33%			
SES					(1, 137)	.79	.38

Group	Number	Percent	Number	Percent	(df, n)	χ²	p
SES Group 1	16	31.37%	35	68.63%			
SES Group 2	21	24.42%	65	75.58%			
College generation status					(1, 136)	.39	.53
FG	16	30.19%	37	69.81%			
CG	21	25.30%	62	74.70%			
Candidacy status					(1, 137)	.25	.61
Not advanced	15	24.19%	47	75.81%			
Advanced	21	28.00%	54	72.00%			
Nationality					(1, 140)	.39	.53
Domestic	30	25.42%	88	74.58%			
International	7	31.82%	15	68.18%			

Table 9.

Frequencies and chi-square results for participants' feelings of exhaustion (index).

	Frequently/Always		Never/Occasionally		(df, n)	χ²	p
Group	Number	Percent	Number	Percent			
All students	**41**	**29.33%**	**99**	**70.67%**			
Gender					(1, 135)	.33	.56
Men	21	27.63%	55	72.37%			
Women	19	32.20%	40	67.80%			
Race/Ethnicity					(1, 115)	1.45	.23
PoC	10	25.00%	30	75.00%			
Non-PoC	27	36.00%	48	64.00%			
SES					(1, 137)	.67	.41
SES Group 1	17	33.33%	34	66.67%			
SES Group 2	23	26.74%	63	73.26%			
College generation status					(1, 136)	.05	.82
FG	15	28.30%	28	71.70%			
CG	25	30.12%	58	69.88%			
Candidacy status					(1, 137)	4.14	.04
Not advanced	13	20.63%	50	79.37%			
Advanced	27	36.49%	47	63.51%			
Nationality					(1, 140)	3.51	.06
Domestic	38	32.48%	79	67.52%			
International	3	13.04%	20	86.96%			

Appendix E.
Survey Measures

Sense of Belonging (Adapted from Good et al., 2012)

Instructions: We would like you to answer about your experience in your department (e.g., the broad group of people involved, including the students in your courses and labs). Response options: 1 (strongly disagree) to 6 (strongly agree).

When I am in a department setting...

1. I feel accepted.
2. I feel respected.
3. I feel disregarded. (R means the order of responses is reversed for analyses)
4. I feel valued.
5. I feel neglected. (R)
6. I feel appreciated.
7. I feel excluded. (R)
8. I feel insignificant. (R)

When I am with my research group (or lab) ...

1. I feel accepted.
2. I feel respected.
3. I feel disregarded. (R means the order of responses is reversed for analyses)
4. I feel valued.
5. I feel neglected. (R)
6. I feel appreciated.
7. I feel excluded. (R)
8. I feel insignificant. (R)

Advisor Belief in Student (Relation-inferred Self-efficacy by Chen et al., 2001)

Instructions: For these questions please rate the extent to which you agree or disagree with each statement about your faculty adviser. Response options: 1 (strongly disagree) to 6 (strongly agree).

My advisor believes...

1. ... I will be able to achieve most of the academic/professional goals that I have set for myself.
2. ... that when I am facing difficult academic/professional tasks, I will accomplish them.
3. ... that in general, I can obtain academic/professional outcomes that are important to me.
4. ... that I can succeed at most any academic/professional endeavor to which I set my mind.
5. ... that I will be able to successfully overcome many academic/professional challenges.
6. ... that I can perform effectively on many different academic/professional tasks.
7. ... that compared to other people, I can do most academic/professional tasks very well.
8. ... that even when things are tough, I can perform quite well academically/professionally.

Maslach Burnout Inventory (Schaufeli et al., 2002)

Instructions: Please rate how frequently you experience the following items. Response options: 1 (never) to 5 (always)

Exhaustion

1. I feel emotionally drained by my studies/research.
2. I feel used up at the end of a day at university.
3. I feel tired when I get up in the morning and I have to face another day at UCSC.
4. Studying, attending a class, or working on research is really a strain for me.
5. I feel burned out from my studies/research.

Cynicism

1. I have become less interested in my studies/research since my enrollment at UCSC.
2. I have become less enthusiastic about my studies.
3. I have become more cynical about the potential usefulness of my studies.
4. I doubt the significance of my studies

Engagement

1. I find my studies to be full of meaning and purpose.
2. My studies inspire me.
3. I am enthusiastic about my studies.
4. I am proud of my studies.
5. I find my studies challenging.