

Exploring Student Perspectives: How Graduate Students in a Life Science Department Define Success

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ABSTRACT

Research in science education often has the goal of enhancing student success, yet there is a dearth of literature related to how students define success for themselves. In this study, we explored how 10 life science graduate students defined the term “success,” as well as their experiences related to success. Using interpretive phenomenological analysis, we discovered that students had definitions of success that included multiple components and that students’ definitions varied widely and were influenced by a number of factors. Students described challenges to their success—including lack of departmental support—as well as supports to their success—like caring relationships with others. Students felt guilty about having definitions that were not wholly academic, and their perceived misalignments between these definitions and those of their advisors or department generated negative feelings and a low sense of belonging. Finally, students described how their definitions of success had changed since entering graduate school. Our results suggest that student definitions of success are complex and that, as researchers and programs seek to enhance student success, they should attend to the diverse perspectives that students have about this concept; this may be an integral strategy to address students’ well-being within academia.

INTRODUCTION

How success is defined within higher education is a complex and important topic. The term “student success” has myriad colloquial and educational meanings; the term can indicate a metric, an independent variable, or a theoretical framework, or it can refer to a process (Weatherton and Schussler, 2021). Given these uses, it is often unclear how the term is defined. Indeed, our previous work revealed that the term “student success” is often invoked within a research context without being explicitly defined (Weatherton and Schussler, 2021). How success is defined is important, because these definitions have cascading impacts on how success is measured, how policy is created, and how students fare within academia. For example, if success is defined solely as an academic construct, then metrics to measure student success may include grade point average (GPA) and standardized test scores. Thus, university admissions policies will likely focus on incoming students’ transcripts and Scholastic Aptitude Test or Graduate Record Examination (GRE) scores, as opposed to a holistic review, impacting students’ outcomes in terms of university admission. Furthermore, the way success is defined may have societal impacts in terms of which students persist within higher education and who then comprises the nation’s future workforce. Thus, these definitions need to be clear and diverse enough to be inclusive of success for all. However, most definitions of success in the literature are outlined by researchers, faculty members, or institutional leaders. Explicitly missing are the voices of students themselves, who are, of course, also experts in student success.

Previous work exploring students’ definitions of ill-defined constructs (e.g., interest, Rowland *et al.*, 2019; failure, Henry *et al.*, 2019) discovered that students have unique points of view, which are not always aligned with the extant literature or institutional

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practices. We hypothesize that similar misalignments exist between students' definitions of success and those present within academic and institutional domains (Brauer *et al.*, 2021; Weatherton and Schussler, 2021). If students' definitions of success are *not* aligned with extant definitions, this may have cascading negative impacts because of the student perception that they do not meet the existing standards for success, and thus do not belong. To explore the impacts of misalignments, we must first examine whether these misalignments exist; while "institutional" definitions of success are relatively easy to glean from extant literature and academic policy, graduate students' perspectives are explicitly missing from the literature. Indeed, to the best of our knowledge, there has not been an empirical examination of how graduate students define "success." Thus, the present qualitative study probes how graduate students in one program define success for themselves both within and outside their graduate program. Methodologically, qualitative studies of student views of success offer the needed nuance and richness to construct these complex ideas. Thus, this study used a phenomenological approach to capture the voices of graduate students in a life science program at a research-intensive university in the southeastern United States. Our study had two objectives: 1) Explore how graduate students in a life science program define success. 2) Explore how graduate students describe their experiences related to success.

How Has "Success" Been Defined in the Literature?

"Success" has been discussed in education literature for more than 50 years, though it has rarely been explicitly defined (Carmichael, 1913; Brogden and Taylor, 1950; Tinto, 1975; Baird, 1985). "Common criteria" measures dominated the nascent field of education research, with reports highlighting the effectiveness of measures like ACT, GRE, and GPA scores to identify successful students (Robertson and Hall, 1964). These studies implicitly defined success at all levels of education as high scores on these relatively one-dimensional, quantitative measures. Contemporaries, like Hartnett and Willingham (1980), highlighted the need for more in-depth measures of success, especially at the graduate level; Hartnett and Willingham pointed to issues like the variability of comprehensive exams across disciplines and how factors like GPA struggled to capture the full range of differences in graduate student performance (Hartnett and Willingham, 1980). In the 1970s and 1980s, researchers debated various factors that influenced student success and proposed models of student socialization and attrition patterns at universities (Panos and Astin, 1968; Spady, 1970; Tinto, 1975). Much of the field's focus during this time was on student attrition, implicitly defining success as student persistence. Of these studies, only Tinto's (1993) work focused specifically on doctoral students' departure from graduate programs, indicating that graduate student success was measured by progress through their degree programs.

Success is defined more often in the modern literature, though there is still little consensus on which definitions of success are most useful to capture intended student outcomes. Much of the recent literature that provides a definition for graduate student success focuses on quantitative measures like time to degree and graduation rates (Gilmore *et al.*, 2016; Zhou and Okahana, 2019; Matheka *et al.*, 2020). Few studies have incorporated qualitative metrics like subjective well-being into their

measures of success (Castro *et al.*, 2011; Fisher *et al.*, 2019). Fisher *et al.* (2019) measured both publication rate and subjective well-being to interpret pathways to student success for underrepresented science, technology, engineering, and mathematics (STEM) doctoral students. While the field may be in the process of developing a more nuanced view of success by incorporating both quantitative and qualitative measures and expanding the populations that it studies, it has still overlooked a critical voice in the pursuit of a definition of graduate success: that of graduate students themselves.

How Do Students Define Success?

While, to the best of our knowledge, there has not been any empirical work examining graduate students' definitions of success, previous work in undergraduate populations has found that these students have diverse definitions of success. For example, O'Shea and Delahunty (2018) found that first-generation undergraduate students defined success in terms of persistence or "defying the odds" and feeling accomplished. Similarly, Oh and Kim (2016) found that students of different cultural backgrounds had divergent definitions of success; for example, Mexican-American students' definitions included helping those in their communities, and Korean-American students often included making their families proud in their definitions (Oh and Kim, 2016). These relatively "nontraditional" definitions of success are not often broadcast by academic institutions—in terms of the structures that they promote, how success is discussed, or how students are implicitly taught about success. We believe that a lack of representative definitions may lead to a host of issues, including a low sense of belonging and poor mental health for students who hold nontraditional definitions of success (Weatherton and Schussler, 2021).

It is likely that graduate and undergraduate students have similar definitions of success, though it is unclear how similar they are, as there is a dearth of literature related to graduate students' perspectives on the topic. Thus, documenting diverse definitions of success in both undergraduate and graduate students will contribute to the gap in the academic literature around success. Furthermore, if these definitions are recognized and broadcast by institutions and leaders in the field, it may also positively impact students' well-being and sense of belonging within academia.

What Factors May Impact Graduate Students' Definitions of Success?

Graduate students' definitions of success are likely to be as unique as each individual within a study, because they are influenced by many factors, such as future goals, past experiences, self-concept, and peer influence, among others. However, to the best of our knowledge, there is currently no empirical work to support the influence of these factors on students' definitions of success. Here, we will review four factors that have previously been linked to students' outcomes in their graduate programs: students' cultural background and family values, academic socialization and identity formation, the student-advisor relationship, and departmental policies and structures. We review these factors because they have been shown to strongly impact students' well-being, persistence, and overall experience within their graduate programs (e.g., cultural background, Chapdelaine and Alextich, 2004; socialization, Tinto, 1993;

Lovitts, 2002; student–advisor relationship, Lovitts, 2002; Sverdlik *et al.*, 2018; departmental policies, Sverdlik *et al.*, 2018). We posit that if these factors impact student outcomes broadly, then they may impact students' definitions of success and experiences related to success in their program as well, though this has not been thoroughly studied.

Cultural Background and Family Values. Attaining success is a goal that many families try to instill in their children. However, the definition of "success" or "achievement" can vary widely by cultural background or family history; for instance, academic achievement may be seen as a means to future career success or as a means to bring honor to one's family (Trumbull and Rothstein-Fisch, 2011). The outcomes of these differences have been examined empirically; for example, Oh and Kim (2016) investigated differences in academic goals between Korean-American and Mexican-American undergraduate students and found that cultural norms and familial expectations had a large impact on undergraduate students' definitions of academic success. Korean-American undergraduate students reported higher or more stringent expectations from family than Mexican-American students (Oh and Kim, 2016). Structural equation modeling by Scheitle and colleagues (2021) found that graduate students' perceptions of "family values" were strong mediators of students' career goals, highlighting the importance that student values may have on their career intentions and thus how they define success. Variation in graduate students' family values and cultural backgrounds certainly influences their experiences while in graduate school, such as students' definitions of an ideal mentor (Rose, 2005), the relative importance of academic independence (Swagler and Ellis, 2003), and experiences of bias (Scherr *et al.*, 2020).

Socialization and Identity. When considering graduate students' definitions of success, academic relationships become especially relevant, as these relationships are one of the vehicles for student socialization. Socialization is the process of learning norms, skills, and values of a particular group or community (such as an academic department). During socialization, students are implicitly taught what is and is not acceptable in terms of work–life balance, values, goals, and future career choices (Lovitts, 2007; Sallee, 2011; Perez *et al.*, 2020). We can imagine, then, that the process of socialization may also work to shape students' definitions of success. At the graduate level, socialization has been hypothesized as an integral step in developing students' academic identities and sense of belonging within a field (Adler and Adler, 2005; Liddell *et al.*, 2014). However, improper socialization can occur when graduate students feel as if they do not "fit the mold" of their programs, and this can lead to negative consequences for students' well-being, self-concept, and intention to persist (Gardner, 2008b; Griffin *et al.*, 2020). Thus, if students have different definitions of success than those conveyed during the process of socialization, they may feel tension between these definitions, and this tension may ultimately lead to negative consequences in terms of students' well-being or persistence.

Student–Advisor Relationship. The student–advisor relationship has frequently been implicated as the most important predictor of the outcome of a student's graduate experience (Golde, 2005; Zhao *et al.*, 2007). Lovitts (2002) outlined the many out-

comes over which an advisor holds influence: formation of a student's academic identity, development of a professional network, and the student's subsequent job prospects. Especially relevant is the advisor's contribution as a mentor; German *et al.* (2019) found that doctoral students who were satisfied with the mentorship they received from their advisors were more likely to be satisfied with their job offers postgraduation. While career satisfaction is merely one way to measure success, this study reveals the integral role advisors play when it comes to influencing student conceptions of success. On the other hand, negative interactions with advisors are prevalent in graduate school and can have detrimental impacts on students' experience and well-being. In a study of graduate students' negative mentoring experiences, Tuma *et al.* (2021) found that nearly half of their participants reported a mismatch with their advisors in terms of work style, values, or career goals and that these misalignments resulted in lower-quality relationships and a more negative graduate school experience. Clearly, as a driver of students' socialization and identity development, advisors hold sway over the norms and expectations around success that are expressed to students (Gearity and Mertz, 2012).

Departmental Structures. Beyond the interactions that graduate students have with those in their departments, departmental structures, like financial resources, graduation requirements, and networking opportunities can also influence student goals and definitions of success. O'Meara and colleagues (2014) found that departments had the ability to positively influence student agency by encouraging multiple career paths, providing information and financial support, and offering mentoring and guidance. Furthermore, departments broadcast their values in regard to success through the structures they promote—like program requirements and employee policies. For example, Bodkin and Fleming (2021) described the lack of formal "family-friendly" policies (i.e., paid leave, childcare assistance) for graduate students in the United States and hypothesized that these policies, or lack thereof, may contribute to women doctoral students leaving their programs at a higher rate than men. This finding suggests that student definitions of success (i.e., having a family *and* a career, maintaining work–life balance) are likely to be influenced by the policies and resources of their programs as much as by the people within the programs.

Study Objectives

The present study on definitions of student success is novel, because it gathers graduate students' perspectives and centers their voices in the literature. Furthermore, this study aims to explore how graduate students describe their experiences related to success within graduate school in order to investigate factors that contribute to student well-being and persistence. Therefore, this study had two broad objectives: 1) Explore how graduate students in a life science program define success. 2) Explore how graduate students describe their experiences related to success.

METHODS

Methodological Framework

To explore how graduate students understand and experience the phenomenon of success within their graduate program, we used an interpretive phenomenological approach, guided by

Smith *et al.* (2009). Interpretive phenomenological analysis (IPA) is couched in a constructivist epistemology and, as such, seeks to capture how participants make sense of their worlds. As opposed to pure phenomenology, IPA seeks to understand participants' interpretation of a phenomenon in the context of their political, social, and cultural contexts. Thus, given our research questions, phenomenology and IPA were the most appropriate methodological tools. Before participants were contacted, a detailed research plan was approved by the Institutional Review Board at the University of Tennessee, Knoxville (IRB-20-05870-XP).

Participants

The most integral criterion for participation in a phenomenological inquiry is that participants must have experience with the phenomenon in question (Creswell and Creswell, 2017). Thus, we recruited graduate students who had completed at least 1 year of their program. For this study, we focused on the experiences of graduate students in a specific life sciences department, as M.W. is a graduate student in the same domain. A critical assumption of phenomenological study is that within interviews and discussions "there is an essence or essences of shared experience" between participants and the researcher (Merriam and Tisdell, 2015, p. 26).

Graduate students in one life science department ($N = 60$; 12% MS and 88% PhD) were recruited in Fall 2020 via an institutional email list to participate in one 40- to 60-minute interview about their definitions of and experiences with success in their graduate program. All individuals who expressed interest and who met the aforementioned criteria were invited to participate. Ten out of 60 graduate students in the department completed interviews. Although master's degree students were not excluded from our recruitment, only PhD students responded to our requests for interviews. Interviews lasted from 40–120 minutes, with an average length of 50 minutes. The interviewer let participants share their experiences and perspectives for as long as they wanted, resulting in the observed variability in interview lengths.

At the time of their interviews, all participants were pursuing doctoral degrees in the same life science department at the same research-intensive university. Our sample was majority female (60%), domestic students (60%; Table 1). There was an equal split between white and non-white students; to protect the identities of our participants, race will not be identified further. Fifty percent of our sample identified as first-generation students (i.e., neither of their parents possessed a college degree). Finally, 50% of our participants had passed their qualifying exams at the time of interview, a step typically occurring in the second or third year of the program, and thus were considered PhD candidates. More than half of the participants had a stated future career goal as a research-focused academic (e.g., tenure-track faculty at a research-intensive university). Participants also mentioned several other career goals, including teaching-focused academic positions (e.g., faculty at a primarily undergraduate institution), careers with nongovernmental organizations (NGOs; e.g., the Nature Conservancy), at governmental agencies (e.g., the U.S. Geological Survey, the Department of the Interior), private sector research, K–12 STEM education, and other careers outside science altogether (Table 1). Note that, because participants

TABLE 1. Demographic characteristics of sample population ($N = 10$)

	Variables	Frequency
Gender	Female	6
	Male	4
Race	White	5
	Non-white	5
College generation status	Continuing generation	5
	First generation	5
International status	Domestic	6
	International	4
Candidacy status	PhD student (prequalifying)	5
	PhD candidate (postqualifying)	5
Career goals	Research-focused higher education	6
	Teaching-focused higher education	3
	NGO	2
	Government agency	2
	Private sector research	2
	K–12 STEM education	1
	Other	1

often cited multiple career goals, the frequency counts total more than 10.

Interviews

Interview questions were developed by the researchers to generally probe the research questions. The goal was to provide prompts that allowed participants to share their ideas broadly. When developing interview questions, the researchers had in mind the literature regarding factors that may influence students' definitions of success (cultural background, family values, socialization, etc.), though a conscious effort was made to create interview questions that were not leading and aimed to capture participants' individual experiences and perceptions. Interview questions went through several rounds of refinement within the researchers' lab group and members of the M.W.'s dissertation committee. After this, interview questions were further edited for clarity, construct validity, and reliability based on feedback from pilot interviews, which took place in Summer 2020 and involved several graduate students from the same research-intensive university as the study population.

To support confidentiality, participants were given pseudonyms before interviews took place so that participants' real names were never associated with their data. These participant pseudonyms are used throughout the rest of this paper. The interviews took place from October through December 2020. After reviewing consent documents with participants, semi-structured interviews were conducted over Zoom teleconferencing software (2020) at the day and time of a participant's choosing. We note that interviews took place during the global COVID-19 pandemic and, as such, were conducted exclusively over Zoom in order to comply with health guidelines. The semi-structured interview questions probed the following topics: participants' definitions of success, why participants decided to pursue a graduate degree, and participants' thoughts on how likely they were to achieve success (Table 2). Furthermore,

TABLE 2. Interview questions

1	I'm curious to learn from your perspective how you would define success for yourself.
2	How would you define success in your program?
3	Where did those ideas of success come from?
4	Tell me about why you decided to get your PhD.
5	On a scale from 1 to 10, 1 being least likely and 10 being most likely, how likely do you feel like you are to achieve your definition of success?
6	How have your definitions of success changed since your time as an undergraduate?
7	Tell me about a time you felt like you failed during grad school. How did this change how you defined success?

participants were asked about what factors influenced their definitions of success. Due to the nature of semistructured interviews, each interview covered the same topics, but based on the participants' answers, follow-up questions allowed each interview to explore slightly different areas within those topics (Smith *et al.*, 2009; Creswell and Creswell, 2017). For example, although the researchers did not ask specifically about graduate students' experiences with the coinciding COVID-19 pandemic, approximately half of the participants mentioned the topic. Interviews were audio-recorded using Zoom teleconferencing software (2020) and transcribed by the primary author (M.W.) using Otter transcription software (2021).

Analysis

We used Smith *et al.*'s (2009) IPA methods to analyze our interview data. The general process of IPA entails: 1) reading and rereading transcripts, 2) initial noting, 3) developing emergent themes, 4) searching for connections across emergent themes, and 5) looking for patterns across cases (Smith *et al.*, 2009).

Each transcript was analyzed individually before noting any themes that transcended interviews; this is essential to the IPA process and draws on the method's idiographic roots (Eatough and Smith, 2006; Smith *et al.*, 2009). Thus, the following process was followed: the transcript was read at least three times by the authors while they separately annotated it to note linguistic and descriptive codes, as well as larger conceptual themes. This was repeated for each transcript, after which emergent themes were developed based on shared participant experiences. Throughout the process, both researchers make a conscious effort to "bracket," or set aside, their preconceptions of student success and the factors that may impact it as well as previous transcripts they had read. More details on bracketing and the inductive coding process in IPA can be found in Smith *et al.*'s guide to IPA (2009).

After reviewing all transcripts independently, both researchers met to discuss their codes and themes and to develop a combined codebook. M.W. then finalized the codebook, which was used to assign codes to all transcripts. E.E.S. then conducted a coding audit by using the final codebook to check the codes assigned to the data. A coding audit helps to develop the coherence and plausibility of the interpretation of the data within an interpretive phenomenological analysis (Smith *et al.*, 2009). It is important to note that the process of "auditing" within IPA is different from the more common process of measuring interrater reliability. Auditing only intends to ensure that the account produced is credible, though it leaves room for the possibility that other, equally valid, interpretations may exist (Smith *et al.*, 2009). Given the constructivist epistemology of our chosen method, a coding audit is the most appropriate way to ensure validity. After a coding audit was completed, M.W.

and E.E.S. reviewed any disagreements in coding together and came to a final agreement on themes.

After all participants' transcripts had been coded and emergent themes were finalized, M.W. performed member checks. This entailed securely sending participants their transcribed interviews with codes and themes annotated throughout. Participants were asked if the transcripts were accurate and if the researchers' codes and themes captured their experiences with success in the graduate program. Four of the 10 participants responded to researchers' requests for feedback, and none of those participants indicated that they had anything to add or edit in terms of their interview transcripts and researchers' interpretations of their experiences.

Validity

Many methods traditionally used to evaluate aspects of qualitative work, like its transferability and reliability, aim to ensure a uniformity of results among researchers. However, within IPA and an interpretive philosophical framework generally, a foundational epistemological assumption is that participants' experiences are individually constructed according to their social contexts; therefore, there is no universal truth to report. Thus, conventional methods of validity are not applicable to IPA. Instead, leaders in the field of IPA discuss that rigor and validity are primarily derived from accurately reflecting participants' lived experiences (Yardley, 2000; Smith *et al.*, 2009; Kirn and Benson, 2018).

We used Yardley's (2000) principles for assessing qualitative research as a framework for providing validity evidence for the methods of this study. These principles include sensitivity to context, commitment and rigor, coherence, and impact and importance. This study demonstrated sensitivity to context through the recruitment of a purposive sample of participants with personal experience with the phenomenon in question. Furthermore, the researchers tried to minimize power differentials between the interviewer and participants by having a researcher of the same power level (i.e., a fellow graduate student) interview participants, as well as conducting interviews at times and in settings that participants chose. This facilitated participants feeling comfortable to fully express themselves and is an aspect of both sensitivity to context and commitment and rigor (Walther *et al.*, 2013; Kirn and Benson, 2018). Rigor was also ensured by a thorough and systematic analysis of the data, using methods like coding audits and clear annotation of participants' transcripts. This study exhibited coherence by logically ordering themes and presenting participants' voices as clearly as possible. Yardley (2000) claims that validity via the principles of importance and impact are met when participants felt their voices were adequately represented, which we ensured through the process of member checks.

TABLE 3. Components of participants' definitions of success and the number of participants who identified with that component ($N = 10$)

Definition	Frequency
Academic achievement	8
Career success	6
Aligned with values	6
Gaining skills	6
Achieving goals	4
Happiness	3
Resilience	3

RESULTS

Research Question 1: How Do Graduate Students in a Life Science Department Define Success?

Participants defined success in various ways, and these definitions comprised many components—from academic and career success to resilience and having a life aligned with students' personal values (Table 3 and Figure 1). Many of the components of participants' definitions of success, while coded separately, were inextricably linked, as Dahlia exemplifies: "I define success as, at least for this program in graduate school, like acquiring the skills that it takes and the resources it takes to have a career that you're happy with and feel like you have an impact." This definition of success included the "gaining skills," "career success," and "aligned with values" codes. Like Dahlia, all of our participants had definitions of success with multiple components, which accounts for the overlapping frequency counts in Table 3.

The most common components within participants' definitions of success included success as academic achievement

(eight participants), career success (six participants), having a career that was aligned with their values (six participants), and gaining skills (six participants). Academic achievement was coded when students talked about success as it related to aspects of their graduate program, like publishing papers, getting grants, passing courses, and graduating. For example, when discussing her definition of success, Lily said, "I mean, if I can get like a pub[lication] every year, that's great, you know, so I mean, definitely publications is part of success."

Academic components of students' definitions were closely tied to career success, which was coded when participants related success to what happened after their graduate program, such as getting a well-paying job, having career flexibility, or being able to get a postdoc position in an interesting field. When talking about how she defined success at the start of her PhD program, Dahlia had a very career-based definition of success: "So, I think, like, I used to define success successes as you know, basically achieving what it takes to become an R1 researcher." However, when interviews took place, Dahlia had a career goal of working outside of academia and science altogether.

In addition to academic and career success, students often mentioned that they would feel successful if they were able to move through their graduate program in a way that was aligned with their values. The "aligned with values" code was assigned to any definition of success in which participants mentioned seeking fulfillment, delineated their value systems, or related their success to a value they had mentioned previously in the interview (e.g., helping others, honesty). For example, David's definition of success included "[finding] emotional and intellectual fulfillment, within a career that also allows me to make money with a product framework that does

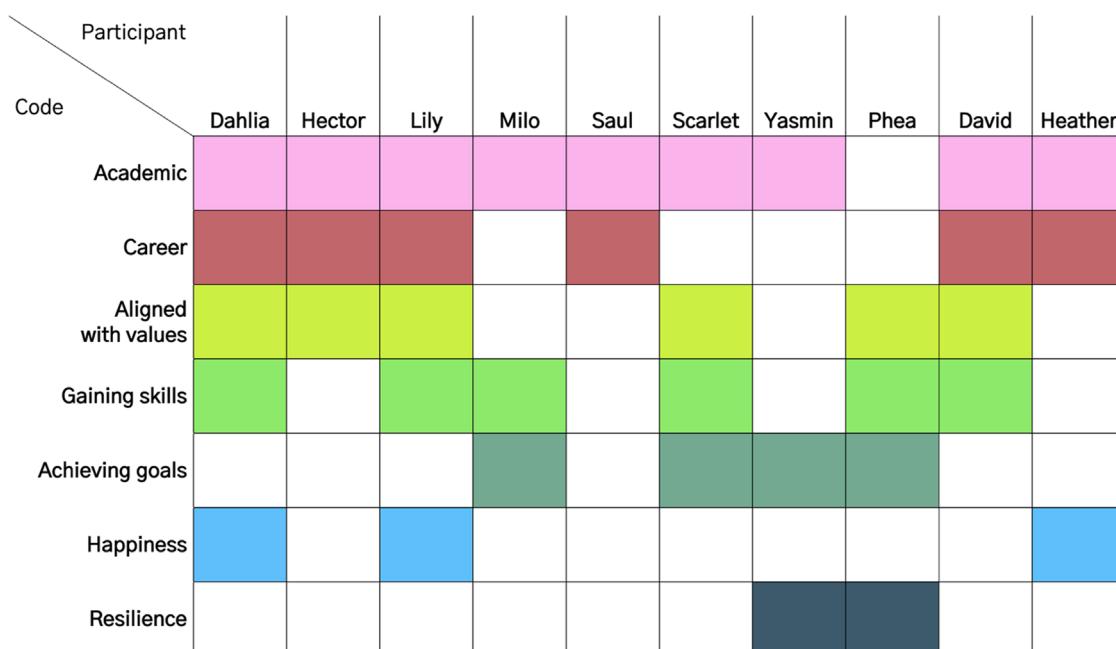


FIGURE 1. Heat map of participants' definitions of success. Participants are listed horizontally across the top of the chart, and components of participants' definitions of success are listed vertically on the left side of the chart. Filled-in sections represent the presence of the component (code) in participants' definition of success.

not require the continual betrayal of self.” David conveyed that he wanted to feel intellectually stimulated by both his graduate program and future career, while simultaneously feeling that he was staying true to himself.

Definitional components coded under “gaining skills” often occurred together with other success components, because students often saw the process of gaining skills (in quantitative analysis, writing, and so on) as necessary to achieve academic or career success. Lily, whose career goal was to get a job in academia, included gaining skills in her definition, as she felt that these skills were required to achieve career success: “If I have the skill set that I can get a job, I feel like I’ll be successful, because if I can’t get a job in academia with a PhD, I’m gonna feel pretty unsuccessful.” This code was employed anytime students mentioned gaining skills, getting better at a certain skill (e.g., data analysis, working cooperatively), increasing their toolset, or any similar statements.

Definitional components mentioned by less than half of the participants were achieving goals, happiness, and resilience. A definition that included “achieving goals” was coded whenever participants explicitly mentioned setting and working toward some goal, as Milo does here: “For me, success is just an achievement of your goal. Even if there are small goal[s], just my plan every day to do everything I planned the day before. [That is] success.” Similar to other codes, students mentioned achieving goals as merely one aspect of their success, and these codes often overlapped with others, as in Scarlet’s definition: “[Success] is both meeting goals, personal goals, professional goals, but it’s also meeting them in a way that fits with your broader value system.” This definition includes both “achieving goals” and “alignment with values” components. The “achieving goals” component was only coded within definitions that *explicitly* discussed meeting goals. If participants mentioned specific goals, such as graduating, or gaining a government career, those would be coded under academic and career success, respectively.

A small group of students ($N = 3$) mentioned that one component of success was achieving personal happiness. The happiness component was coded whenever participants specifically mentioned happiness or being happy, whereas “feeling fulfilled” or “doing what I like,” while similar in sentiment, would have been coded under “aligned with values” and “career success” components, respectively. Students often cited the happiness component in opposition to a previous way of defining success, as Lily did: “Happiness has definitely factored into success as I’ve gone along, because I realized you can make yourself completely miserable and [in my] master’s [program] I definitely struggled with that.” Here, Lily mentions her master’s program, where she felt she did not have a strong work-life balance and prioritized getting her work done over her mental health.

Definitions of success that included a “resilience” component were often mentioned in conversations related to students’ mental health. A definition of success that included resilience was coded anytime students mentioned “resilience” specifically or otherwise mentioned overcoming obstacles or recovering quickly from failure. Phea, after having an especially difficult year in graduate school, cited resilience as the most important component of her definition of success:

And I think a lot of [what] I realized is that being resilient is pretty critical. I’ve had a couple of personal problems ... the last two years have been more challenging than, you know, compared with the rest of my life. And so, I think that I’ve seen that people who are able to bounce back and get back on the wagon tend to just be happier. And, you know, forget the outcomes, they just tend to have a better quality of life. And so, I think I want that for myself. Yeah, I realized the importance of resilience as something really integral to success.

Indeed, in both “happiness” and “resilience” definitional components, students seemed to be prioritizing their own quality of life over outcomes, as Phea indicated.

Overall, the 10 participants had an average of 3.7 components to their definitions of success, with a range between 2 and 5. There was no success component that every participant included in their definition of success (Figure 1).

Factors That Shaped Participants’ Definitions of Success

In response to what shaped their definitions of success, participants mentioned five factors: family and cultural values ($n = 7$), past experiences ($n = 6$), friends or other students ($n = 5$), personal values ($n = 5$), and academic advisors ($n = 2$). Family and cultural values were the most commonly mentioned factors, with family and cultural values being coded anytime a student mentioned formative experiences with their families, cultures, or how they were raised. These values were very important to Hector’s definition of success: “I think that [my definition of success] comes from a lot, um, a lot of probably family values. And just a lot of just my upbringing where, you know, my parents always encouraged me, my siblings always encouraged me to make a difference in your community to, you know, to use your gifts to help bring out the best in other people.” Indeed, Hector detailed that his family values influenced his personal values, which drove him toward a career teaching others about biodiversity and the importance of local habitats, thus his motivation for completing his graduate program.

The code “past experiences” was used when participants cited any past experiences that did not fall into the other categories (e.g., a past experience with an advisor would fall under “academic advisor”). Past experiences, like experiences working in their intended career fields, helped students learn what success metrics and definitions were practical, as Lily describes: “Yeah, I think the definition of success comes [from having] ‘real person jobs’ in between my master’s and this [my PhD], and just finding out what some of those opportunities were like beforehand, and what could I be sustainably happy with.” These experiences in the “real world” gave students like Lily concrete examples of future career paths that they could use to support their definitions of success.

“Friends or other students” was coded when participants mentioned interactions or conversations with others that influenced how they thought of success. These interactions often drove students to define their own success *in opposition* to how they saw friends or other graduate students defining the term. For example, Heather’s definition of success was greatly influenced by her experiences with others in her program: “Moving into graduate school has even more cemented that I’m seeing students that look successful in their academic life but may not be successful in other realms of their

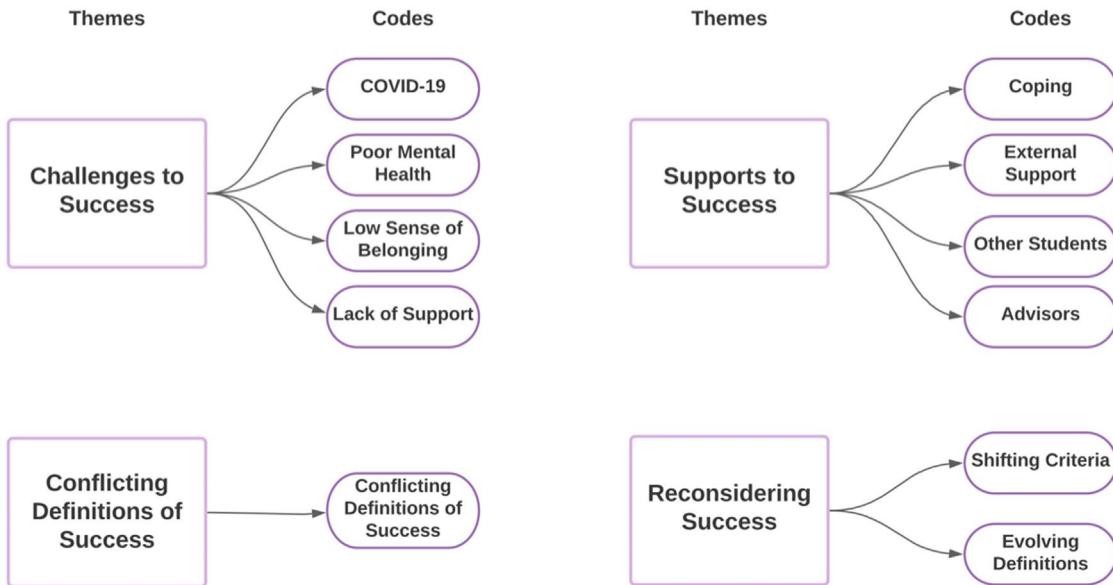


FIGURE 2. Themes and codes present within participants' interviews. Squares represent themes, while ovals represent codes.

life.” Indeed, Heather’s definition of success included academic and career components, as well as striving for happiness.

“Personal values” was coded whenever participants mentioned forming their definitions of success in accordance with specific personal values. If participants just mentioned “values” generally as shaping their definition of success, researchers followed up to investigate whether those were personal, family, or cultural values or some combination thereof. Personal values mentioned by participants were often the driving forces behind their careers in academia, participants mentioned curiosity, the need to help others, and striving to solve challenges. For example, Phea mentions that her whole life is motivated by solving problems and helping others, and these motivations naturally impacted her definitions of success: “I think my, both these definitions of success to me are very personal … they’re what I aspire to, rather than something that I’ve … that I’ve really just inherited from family or something external. Like, I’m very motivated by solving problems with a connection to causes that I care about. I think that comes from just my own my own motivation.” Participants who mentioned the influence of personal values seemed to be very passionate about their values and were often able to explicitly tie these values to their impact on their definitions of success, career goals, and overall motivations.

Finally, “academic advisor” was coded when students specifically mentioned current or previous academic advisors. Interestingly, both times academic advisors were mentioned as influencing a students’ definition of success, they were academic advisors from students’ undergraduate research experiences. Here, Scarlet describes how her former advisor completely changed the way she saw success: “She [my undergraduate advisor] instilled in me that just because you reach your goals does not make you successful. And that there are so many other ways to find success.” This may suggest that the influence of undergraduate advisors can have persisting impacts throughout graduate school.

Research Question 2: How Do Graduate Students in a Life Science Department Describe Their Experiences Related to Success?

Participants’ discussions about success were categorized into four overall themes that resonated throughout the interview data set. These findings were less about participant definitions of success and more about things that had happened to them related to success in graduate school. These themes were “challenges to success,” “supports to success,” “conflicting definitions of success,” and “reconsidering success” (Figure 2). Taken together, these themes highlight these graduate students’ journeys as they realized what success meant to them, what they needed to be successful, and how to navigate misalignments between their definitions and those of others in the system. In this section, we discuss each theme and its codes.

Themes 1 and 2: Challenges and Supports to Students’ Success

The first two themes we describe are diametrically related: challenges and supports to students’ success. Participants discussed at length the challenges they faced and how those challenges resulted in perceived barriers to success. These may have included everyday issues like trying to get in touch with an advisor, to global issues like the fallout from the COVID-19 pandemic. While no two students expressed the same set of challenges, there were four codes within this theme: “poor mental health,” a “low sense of belonging,” a “lack of support,” and the “COVID-19” pandemic. Fortunately, in addition to these challenges, students cited many factors that supported their success, well-being, and persistence. These factors were encompassed by four codes: “coping,” “external support,” “other students,” and “advisors.” Each code is described in more detail below.

Challenge: Poor Mental Health. Graduate student mental health has been a topic of concern for many advisors, departments, and institutions across a broad range of academic domains. Students in our study, like Yasmin, mirrored these

concerns: "I think that science and academia can bring you to a lot of psychological problems, like anxiety, depression, and I have them all."

These struggles with mental health often led to downstream challenges with motivation, meeting deadlines, and persistence in their program. "Poor mental health" was coded any time participants talked specifically about their mental health issues, like anxiety and depression, or whenever participants discussed feeling extremely stressed or overwhelmed or indicated that their experiences in their graduate program were distressing. For example, Dahlia discussed how, early in her program, she felt very depressed and trapped, which resulted in a lack of motivation toward her dissertation project and her program generally: "I was, like, very depressed my first semester ... and so I just felt like very trapped. And it was like, every single day, I, like, very seriously contemplated dropping out because, like, I wasn't getting any grants, and I was very understanding of why I wasn't getting any grants, because, like, it was a dumb project that I didn't care about."

While many students in our study discussed poor mental health, many also recognized that struggling with their mental health was nothing to be ashamed of. Indeed, a common conception among the participants was the idea that "a lot of academics" or "everyone" struggles with similar issues, so students should not feel embarrassed about seeking help. Some students, like Scarlet, even mentioned getting help as a catalyst for examining their definitions of success: "I started doing therapy ... and having that external support [her therapist], having a space to really kind of, like, unpack the reasons behind I was feeling as though my success was only dependent on, you know, how many papers I put out, or my grades and things like that, really helped me better define what success is." Thus, while most students in our study seemed to cite personal mental health struggles, many of them knew how to get help, and often expressed de-stigmatized conceptions of seeking and growing from professional help.

Challenge: Lack of Support. One challenge to success mentioned by the participants was a perception of a lack of support, either from their advisors specifically or the department generally. For example, Dahlia discussed a lack of support from the department in relation to her intended career goals, which, notably, were to find a career outside academia and science altogether: "I think some of my struggle comes from the fact that I'm trying to follow a fairly nontraditional path. And so, I have like, no clear trajectory in which to benchmark myself against." Similarly, Heather noted a lack of social support from her department: "The department isn't great at building that support and that community structure." These quotes expressed a desire for both defined goals and community as essential to graduate student success.

While this code was also likely impacted by the pandemic, students mentioned a lack of support both before and during the transition to virtual instruction. Dahlia mentioned issues with support both before and during the pandemic: "Support from your advisor is like, so important. And it's something that is a lot better now, but like, at the beginning [my advisor] and I just like did not know how to communicate at all ... and like, they would never reach out to have meetings, like I would always have to reach out to them and then it would feel like I'm

defending my right to be in the program every time I would talk to them." This quote highlights the link between feeling supported and feeling like one belongs in an academic program. Questioning the support from her advisor also made her question whether she belonged in her PhD program. Later, she mentioned that this changed after some time: "[Now] I realize that, like, [my advisor] just wants me to, like, do what makes me happy. Like, they want me to do something that I like, and will get me to a career that I'm happy with." After a rocky start, Dahlia and her advisor figured out how to communicate in a way that worked for them, and Dahlia felt more accepted and supported.

Challenge: Low Sense of Belonging. Like Dahlia, many students struggled with feelings of belonging in their program. A few students felt that the relatively narrow focus of each lab in the department made it difficult for them to connect with others about their work, while others felt a lack of diversity in the department made them feel like an outsider. For example, Heather discussed how the topics studied by faculty, while interesting, made it harder for her to connect with peers in the department: "But just like, my focus is very different than a lot of folks [in the department] and so it's harder to go and engage with like, all of the seminars that talk about plants and soil, which is great for a lot of people, but not necessarily what I want to do. So, yeah ... the department isn't really great at it [making me feel included]." Some participants focused on a lack of diversity among the faculty. Indeed, one of our participants indicated that the lack of diversity within departmental faculty made her feel as if the program was not "built" for people like her: "Um, but I think a lot of it [feeling a lack of belonging] comes from like, we're pretty white, straight, cis department all like people who have succeeded in the existing system. And so, it's not necessarily built for a first-generation queer, female."

Another factor driving students' sense of belonging was the alignment of their definitions of success with those of their advisors. Although she had almost completed her program, Yasmin said that she had never shared her personal definition of success with her advisor due to a fear that it would not align with her advisor's definition and she would be seen as less professional,

I don't think we ... I don't think we talk about [our definitions of success]. Um, I think that most of the people I've been with, they don't have the same definition of success that I do. Everyone that are like PIs or professors, I think they measure success with papers, numbers of papers, grants, and, you know, those kind of things. So, I think that I'm somewhat an exception. Yeah. For me, it's also a little bit embarrassing. Because I feel like, as a scientist, we should all have that same definition [of success]. But we don't, and most of scientists think that it's like, yes, number of publications. [If I shared this definition] like, other scientists might consider me like, maybe not adequate or for the job.

While Yasmin's reluctance to share her definition with her advisor may seem like an extreme case, many participants in our study shared similar worries about misalignments and seeming unprofessional by having definitions of success that were not "academic enough."

Challenge to Success: COVID-19. Interviews took place during the Fall semester of 2020, when participants were dealing with the COVID-19 pandemic, lockdown, and transition to virtual instruction on top of existing stressors and responsibilities. Thus, it was not surprising that COVID-19 surfaced as a major challenge to participants' success and well-being. This code encompassed anytime participants discussed COVID-19 or issues resulting from the pandemic. For example, Phea, an international student, discussed how the global pandemic, political turmoil in the United States, and cancelled plans all had a synergistic effect on her mental health: "But this year has been really difficult. Because I felt like I was doing fairly well, and I was really excited about summer because I had this grant and I recruited some undergrads and got them funding for the summer, I was really, really pumped to get some stuff done this year, and COVID just came like, like a wave and laid those plans to rest a little bit. And so, I needed to refocus and do things that were more attainable and had to change a lot of plans."

Beyond changing plans, COVID-19 also forced many graduate students into isolation. Sense of belonging, social connection, and students' motivations are inextricably linked, and Hector expressed how working during isolation presented a challenge to his success and motivation: "I guess my motivation has probably decreased in general, you know, I find it much harder to get up and go to work in the morning, you know, when I'm gonna be sitting in front of a computer for six or eight hours typing code. I think it has a lot to do with COVID, that we spend so much more time in quarantine and isolation that you kind of, you know, it's like, kind of a downward spiral in a lot of ways." Certainly, this code was unique to the timing of this study and captures a layer of nuance that likely influenced many other factors related to student perceptions of success.

Support: Coping. The code "coping" refers to all of the ways that students conceptualized their progress and worked through the challenges within their graduate program. For example, Heather explained that remembering that her work was merely one aspect of her life helped her recover quickly from failure, in an example of an "accommodation" coping strategy: "Being able to compartmentalize [that] my graduate work is not my self-worth, or is not my success, and sort of sort of compartmentalizing ... like, I'm not a failure, just because I failed at this part of grad school, I think really helps." By doing this, Heather chose an adaptive strategy to cope with her graduate school stressors.

Another strategy that students employed was distraction, which could be viewed as a negative strategy, yet seemed to be used in a positive way by these students to establish healthy boundaries around their work-life balance. For example, Hector felt a lot of anxiety related to his research, but used "rewards" like participating in his hobbies in order to get through stressful situations: "That's kind of what I look forward to. Yeah, you know, when I'm leaving the lab, or when I'm coming home from research, I can say, okay, tomorrow, you know, I get to go work out or tomorrow, I get to go soccer or teach, you know? And it's a huge staple in the PhD pursuit, to have the other things in life that you can really rely on to get you through the research aspect." Although students often listed a number of challenges in their graduate program, adaptive coping strategies helped them to set boundaries, maintain a work-life balance, and feel positive about their progress.

Support: External Support. Students cited extensive support networks to bolster success in their programs. When these support networks included people outside academia (e.g., parents, therapists, partners) these were coded as "external support." These external individuals were often integral for students to get an objective opinion on a situation, see a problem in a different light, or just to hold space for students to *not* think about their graduate work. For example, Dahlia discussed that conversations with her friends and her family helped her to relax and take her mind off her graduate work. Another way that Dahlia's family, specifically her mom, supported her success was by providing a sounding board for her to work through her values and how those interacted with her goals for her PhD: "Talks with my mom have, like, very specifically helped me go through value orienting ... like, explicitly thinking about the outcomes [that I want from my PhD] and why. She [my mom] helps me to figure out how to, like, internally validate and not judge myself based on other people's progress." Thus, Dahlia's family and friends were perceived as supportive because of their objective advice and their being external to her program.

External supports, like family and friends, often provided essential affirmations that buoyed students' spirits, such as Lily's partner, who reminded her that she did not have to be constantly striving for success as long as she was happy: "If you're happy being a big fish in a small pond, that's okay. Like, you don't owe it to anyone but yourself." Reminders like this and other affirmations from external support systems were invaluable to graduate students' mental health and their conceptions of success in their programs.

Support: Other Students. Another aspect of students' support systems were other students in their programs or in similar graduate programs. These students were all figuratively "in the trenches" together, so they could offer valuable advice, share previous experience, and perhaps most importantly relate to issues and complaints that graduate students expressed. Heather found that other students in her program supported her by simply being great friends. These friends helped to create "a better work-life balance and community structure." Scarlet found that having conversations with graduate students outside her department built strong friendships and helped her clarify her definition of success: "Also just becoming closer friends with people in different PhD programs. They talked about ways in which they thought about their own success. So, it wasn't kind of the same thing over and over again, that you oftentimes hear from [my department], so I was able to get perspectives from multiple different people in the program." This suggests that peers in particular help to examine conflicts between departmental and individual definitions of success.

Support: Advisors. Perhaps the most important factor that supported students' success was students' relationships with their advisor. Time and time again, education literature has found that the student-advisor relationship is one of the most important predictors of graduate student persistence and academic success (Sverdlik *et al.*, 2018). In our study, participants discussed myriad ways that their advisors supported them, from using their institutional knowledge and their knowledge of the field and career opportunities, to simply offering

emotional support and affirmations. For example, Heather's advisor supported her by "sort of helping me establish a network and helping me shape where I want to go ... just opening doors." This indicates a potential link between advisors and external support networks.

Students, especially those who are new to academia, rely on their advisors for important systemic socialization. David, a first-generation college student, describes how his advisor shared institutional knowledge with him by explaining how to navigate the university: "Here's how to finagle this system, 'here's how to exploit this sort of motive bureaucracy.' 'Here's how to b***s*** your way through X or Y.' 'Oh, those things are excellent professional assets' stuff like that."

Especially for first-generation graduate students, advisors can be essential for learning how academia works. Scarlet, another first-generation college student, also describes receiving similar support from her advisor: "And I think also, one way that he helps with success is because he's so well connected at this point. And is that at the university and in the field for so long? You know, specifically with administration issues, he knows exactly who to email exactly who to talk to, and how firm to be. And that's something that I didn't necessarily know that an advisor would be helpful in." As Scarlet mentions, the need for this type of institutional support may not be obvious to some students until they recognize the benefits of this type of support.

Theme 3: Conflicting Definitions of Success

The theme of "conflicting definitions of success" came up whenever students described a difference between their definitions of success and those of their academic environment. In this section, we will talk about this theme generally, and then discuss the emotional repercussions of students' perceptions of these conflicts. Such conflicts could come up in conversations with advisors, experiences with other academics, or simply students' perceptions of how success was defined within the department. Hector, who had very negative feelings toward his university and the university system generally, felt that most universities prioritized profits over their students and their students' success,

I think we're kind of stuck in a system where we don't get to necessarily define success, you know, that, that we're stuck in a bit of a rat race, you know, where success is defined by our advisors or institutions, kind of the academic establishment ... so I think the issues of defining success are far beyond even [my institution], it's this whole interconnected web of all these big schools around the country that have jointly established what they perceive to be success, and then they try to force it on graduate students undergrads to feed them into this pipeline to bring in money to the university. Um, yeah, it's a corrupt system for sure.

This belief made Hector feel like he was stuck in a system where he had to "crank out six or seven publications, write a bunch of grants, go get a postdoc somewhere, and then you enroll into an R1 institution and do the same thing." Hector felt that these requirements were in opposition to his desire to become an excellent teacher, engage in community outreach, and foster future researchers. These beliefs, along with frustration about his ability to change the system or be listened to by

his advisor or department, resulted in Hector feeling trapped and unable to achieve success.

Milo was similarly frustrated with how he felt success "must" be defined in order to be recruited for a career postgraduation. With the hopes of getting a career in academia after his graduate program, Milo had shifted his definition of success toward one that was more aligned with that of "academia" broadly:

I see how people value you just because of your papers. And I [was] like "wow, man, I need some good papers.' Having a very good paper and high impact factor [can] just change your life. So, that changed my focus to, for example, prioritize papers compared with other goals ... like, conference[s] or this kind of stuff. Yeah. Because people don't look at how many conferences you attend[ed]. Were you instructor of record? Okay, you are in grad school, busy at teaching, and then you end up with zero paper[s] and nobody wants to recruit you.

When asked if these were just the metrics that his field used to measure success, Milo replied that "it's just everybody in academia" who measured success that way, suggesting that there was no way to get around these definitions.

Beyond frustration, when students felt that they were faced with these conflicts, they also felt distressed or as though they were not cut out for the rigors of academic life. This was especially true when students felt that their definitions of success were misaligned with those of their advisors. This was the case for Lily, who, while not as distressed as other students, felt stressed that her definition of success was not enough compared with how her advisor would define the concept,

And [my advisor] is constantly going for, like, [governmental agency's] grants ... all these huge grants, so I'm sure their success would be raking in lots of grants, and then getting lots of publications in high impact journals. Like, I don't know ... don't [get] me wrong, I'd love a high-impact journal. But if, you know, if I get an open journal that people can access, and it's out there, I'm thrilled to death. So, there might be like, differences in like tiers, like, I'm happy to just get it out there. And then they're wanting me to shoot for up there, which can be stressful.

Lily's definition of success mainly focused on her impact on her community: "I feel like having a local impact is super important. Because otherwise, why are we doing it? I mean, don't get me wrong, it's important to leave your mark scientifically." And, although she recognized the importance of academic achievement, she felt as if her standards may not be rigorous enough for her advisor; thus, the pair had never explicitly discussed definitions of success.

Discussions within this theme were often laden with guilt on the students' part, like Lily's belief that she was on a different "tier" than her advisor. These feelings of guilt or shame around students' definitions often led to the idea that the student had to have one "public" definition of success and one "private" definition, where public definitions were often academic and career-based, based on students' perceptions of their fields, while their internal definitions often included more nuance and a focus on well-being or things students enjoyed. For example, Yasmin wanted to have a career that was not only academically rigorous but also included time for her family, though she felt

like she could not tell her advisor that: “I am applying for a postdoc, right? And so, my advisor [has been] saying, like, why don’t you apply [to] this? Why don’t you apply here? I’m thinking inside my head, I’m thinking like, because my husband won’t be able to come with me, or things like about family. And I don’t say it. It’s just immediately you think about like, no, that will make me look weak here.” Yasmin worried that any definition of success that was not solely career based might make her “look weak” in the eyes of her advisor or “maybe not adequate for the job” in the eyes of future employers. Thus, Yasmin kept her personal definition of success and her dreams of starting an NGO in her hometown to herself, while she focused on the more common “logical” path of getting a postdoc position.

Theme 4: Reconsidering Success

Throughout their interviews, students discussed the process of creating and reshaping their definitions of success—from the factors that influenced their definitions to how their definitions had changed over their graduate programs. For example, Heather, whose definition of success centered on happiness and career success, had to redefine what career success meant to her: “[My definition] shifted [in the] sense of what I want out of a job, and like, I guess better evaluating what it would mean to stay in academia versus industry and how I’m defining my happiness.” While her definition of success stayed mostly the same, what she considered to be career success expanded after having positive experiences working in a nonacademic career, and this type of change was coded under “shifting success criteria.” Students described two types of changes to their definitions: changes to their *metrics* of success while their definitions stayed the same, coded under “shifting success criteria,” and changes in their *definitions* over time, which were coded under “evolving definitions.”

Shifting Success Criteria. A handful of students felt that the way they defined success was fixed, and instead it was their criteria for success or their metrics of success that shifted throughout their programs. For example, Lily’s definition of success included being happy and finding career success, and while that had been true since she was in high school, she described the fluidity of her criteria: “But I feel like I don’t know, maybe I have a more concrete view of what success is, but the concrete is kind of like fluid. So as long as I’m, you know, not absolutely hating what I’m doing. And I continue to like, work with animals to some degree. I’m pretty happy.”

Oftentimes, these metrics changed as students’ situations changed, in terms of changing projects, career paths, or life changes outside their graduate programs. Here, Saul describes how career success will look different at each stage of his career: “So, if I speak about success in my career, maybe after the PhD success would be like having publications and postdoc, et cetera. But during the PhD, would it be maybe like, meeting new people that are important in their fields, contributing to the area of research, expanding your horizons and publishing, right? I think [it] kind of fluctuates. I think the, the definition is quite the same, but the importance to each item changes through time.” These students thought deeply about metrics and measurements for their success. While students who considered success metrics in this way did not make up the majority of our participants, their mindset is an especially interesting one for future research.

Evolving Definitions. Within their discussions of success, students often described a transition from an “outward” to an “inward” definition of success as they progressed through their graduate programs. Where initially many students had defined success in comparison to others, over time they shifted toward definitions that focused on internal validation. Here, Yasmin describes this process: “Like, I think at the beginning [success] was just to be a good competitive scientist, student, writer, researcher. But that brings you into the comparison and the competition … I don’t think you could target success if you’re constantly measuring by comparison. Hmm, you know what I mean? Um, so, at points success in the PhD was just finishing like, yeah, closer to the end line it was just finishing, just like graduating.”

Students in our study discussed the stress that came from the “comparison cycle,” the process of constantly comparing their success with that of other students in their programs or other scientists in their fields. Once they were able to focus on what success meant to them, students were able to have a much more rewarding graduate school experience. For example, after issues with both her advisor and her field season, Dahlia took time to re-evaluate the direction of her program and how she saw success,

Basically, there was a lot of s**t that went down with my advising situation last spring that coincided with like the complete failure of my field season. Yeah, and I took about like three weeks to have a complete mental breakdown. And then like, evaluate what I actually wanted without like trying to follow what someone else has already done. And basically, you know, took bits and pieces that I enjoyed from these other career paths, and I’m now trying to like, formulate my own ... and it’s brutal, but it’s fun now.

For participants, reconsiderations of success clearly required deep thought and reflection that ultimately reshaped their thinking about what success looks like in their programs.

DISCUSSION

In this study, we documented life science graduate students’ definitions of the term “success” and described these students’ experiences related to success within their graduate program. We found that these graduate students had multiple, diverse components within their definitions of success that ranged from academic and career-focused aspects to those that centered on personal values like happiness and resilience.

Previous literature strongly linked cultural and familial backgrounds, socialization, relationships with advisors, and departmental structures to graduate students’ well-being and academic outcomes (Tinto, 1993; Lovitts, 2002; Chapdelaine and Alexitch, 2004; Oh and Kim, 2016; Sverdlik *et al.*, 2018). We posited that these factors may also be related to students’ definitions of success and their experiences with success in their program. Indeed, participants described that their definitions of success were most often shaped by their past experiences and family values, and that their relationships with their primary advisors were an integral support to their success during graduate school. Our study also revealed the importance of external supports in the form of friends, significant others, and mental health professionals to students’ perceptions of success. Finally,

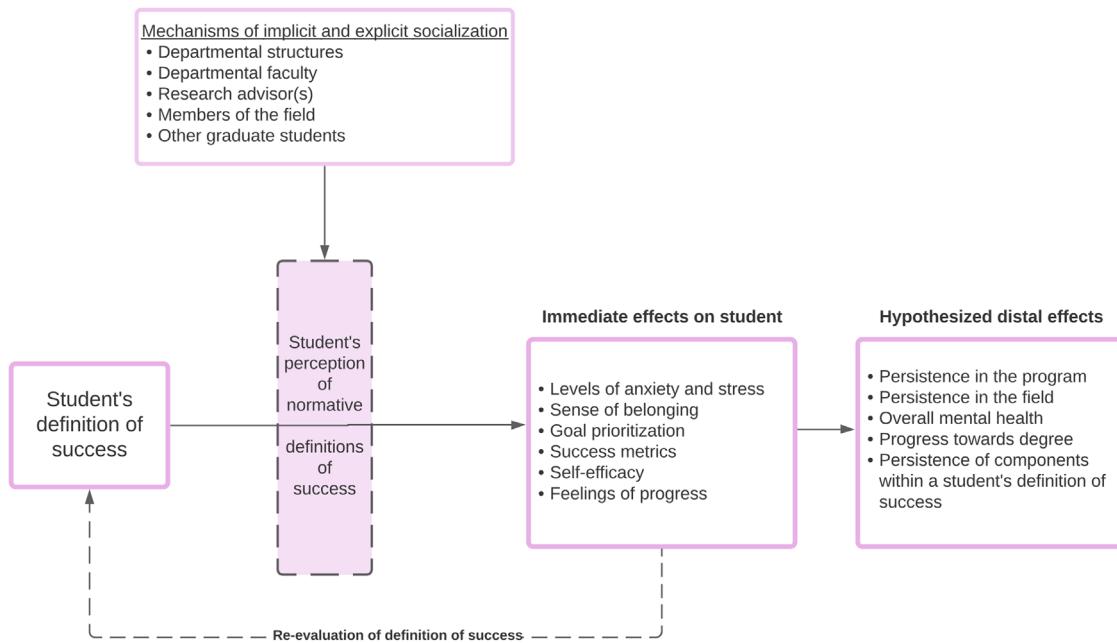


FIGURE 3. Hypothesized interaction between graduate students' definitions of success and normative disciplinary definitions and resulting outcomes. Students' definitions of success are influenced by their perceptions of normative definitions of success within their fields (i.e., how success "should be" defined). Normative definitions are conveyed by implicit and explicit socialization factors such as departmental structures and interactions with faculty. Perceptions of these normative success definitions act as a filter (represented here by a dotted border) that students' original definitions pass through. Alignment or misalignment of these definitions then potentially results in a number of immediate and distal outcome variables.

our study brought to light students' perceptions of misalignment between their and their advisors' (or department's, or institution's) definitions of success. They clearly articulated an understanding that there was a need to project one set of success definitions while perhaps having a different hidden set, and this had implications for some students in terms of their mental health and sense of belonging. This finding highlights the importance of articulating inclusive definitions of success within academia and providing avenues for future research aimed at diversifying graduate education.

Our data suggest that, while students have their own definitions of success, those definitions are influenced by students' perceptions of how success "should be" defined within a field (i.e., normative definitions of success). Students' perceptions of normative definitions are likely shaped by the process of academic socialization (e.g., through interactions with their advisors, faculty members and others). We hypothesize that, if students perceive that their definitions of success are not the same as how success "should be" defined in a field, then these students may experience a reduced sense of belonging. Furthermore, our results suggest that this misalignment affects a number of other outcomes, such as students' feelings of progress, levels of anxiety, and how students re-evaluate success. We represent these findings in Figure 3. In this figure, students' definitions of success are "filtered" through their perceptions of normative definitions of success within their fields, which are impacted by the socialization process. This "filtering" has immediate outcomes, which were experienced by the participants in this study, as well as hypothesized distal effects. These data suggest that widening how success is defined within academia and studying how graduate students perceive and experience

the process of socialization may be keys to increasing sense of belonging in graduate programs (Figure 3).

Prior research related to student success has mainly focused on understanding and leveraging factors that increase student success within higher education (e.g., Hepworth *et al.*, 2018). However, few studies have centered students' experiences related to success. We have previously suggested that, without the explicit inclusion of student voice, academic institutions are likely to continue to uphold hegemonic norms that perpetuate unequal persistence of students within higher education (Weatherton and Schussler, 2021). Thus, amplifying the voices of graduate students is important to broadening the understanding of the many ways that success can be defined and experienced within STEM higher education.

Graduate Students' Multiple Definitions of Success

While previous work has investigated undergraduate students' definitions of success (e.g., Oh and Kim, 2016; O'Shea and Delahunty, 2018), to the best of our knowledge, this is the first study to explore graduate students' definitions of success. Every participant in our study had a multifaceted definition of success. Further, no two students had the same definition of success. Students' definitions included many components; some of these components, like academic success and resilience, are well supported by previous work. For example, work by O'Shea and Delahunty (2018) found that first-generation undergraduate students defined success as "getting through the day with a smile on my face," among other sentiments related to grit and resilience. This study provides novel descriptions, however, of some components that students included in their definitions of success, like achieving goals or alignment with personal values.

Given this diversity in definitions of success, discussions about student success within STEM higher education needs re-evaluation; as our previous work has found, education researchers oftentimes refer to and measure student success as a monolith (Weatherton and Schussler, 2021). But our results suggest that these broad generalizations are inappropriate and fail to capture existing nuance within students' perceptions.

These findings have implications for the metrics graduate programs use to determine graduate students' success. We believe that broadening metrics of success within graduate education (e.g., to include those that measure students' development as educators) will better represent graduate students' unique definitions of success. Furthermore, broader evaluation metrics are more appropriate to exhibit graduate students' growth within the many roles they occupy within a department. One option would be to have many metrics available in a graduate program, permitting the advisor and student to customize the metrics based on the goals of the student; this would provide a more nuanced way to assess progress of students in programs.

Graduate students exist within a unique educational context, wherein they are not only students, but also act as teachers, researchers, employees, and more (Winstone and Moore, 2017; Reid and Gardner, 2020). We think that some participants may prioritize different components of their definitions of success for these different roles. For example, when Hector thought about being an educator, he described success as "using your skill set to bring out the best in everyone around you," whereas in his role as a researcher, he described success as "crank out six or seven publications, get a bunch of grants, [and] you go get a postdoc somewhere." This malleability is supported by previous work done on graduate student role identity (e.g., Jazvac-Martek, 2009; Winstone and Moore, 2017; Reid and Gardner, 2020), which has posited that graduate students switch between their multiple roles as they work through the process of identity work (i.e., the process of refining their academic identities; Winstone and Moore, 2017). Many components make up students' academic identities, including students' perceptions of group membership and social categorization (Camacho *et al.*, 2021); we posit that an important, yet relatively unstudied aspect is how students' identities and definitions of success are related to each other.

Misalignments and Conflicts within Students' Definitions of Success

Given their multiple roles, developing identities, and complex definitions of success, it is not surprising that graduate students in our study faced conflicts and tension among these many factors. Definitions of success, much like role expectations, can develop during the process of socialization. During this process, students may prioritize certain roles and definitions over others, based on explicit and implicit feedback from those around them. Previous work has found clear evidence of conflict between graduate students' multiple roles (Fairbrother, 2012), and our results show similar conflict between students' multiple definitions of success. For example, participants felt that one could not be seen as prioritizing both social and academic success. This finding has implications for graduate student persistence, a well-known and extant issue within higher education. Graduate students who perceive conflict among aspects of their definitions of success are likely to feel anxiety in a similar

way to those who experience role tension (Winstone and Moore, 2017). Over time, these feelings may act as a "selective pressure" against students with diverse or culturally "other" definitions of success, though this is speculative, and more research is needed in this area.

Beyond the tension that students felt among their own definitions of success, participants also cited tension between how they defined success and how success "should be" defined by scientists in a field. Oftentimes, students described this as feeling that their definitions were "wrong." Weidman and colleagues (2001) discuss that the process of graduate student socialization is driven, in part, by advisors and departmental culture. This is supported by our data, which reveal that students often described feeling that their definitions were "wrong" after interactions with their advisors, a member of the department, or even a departmental policy. For example, Dahlia felt that her definition of success, which included factors like happiness and living a life that was aligned with her values, needed to change for her to be a competitive scientist. Her perception was informed by her department's yearly review, which focused mainly on research productivity and meeting graduate school deadlines; to Dahlia, this was an explicit signal that her definition of success was not correct. Furthermore, students in this study felt strongly influenced by the norms and culture of the department, which they cited as one that was focused on productivity and research over teaching and communication and that set unrealistic standards for graduate student achievement. These implicit norms made participants in this study feel stressed and often had a negative effect on their well-being.

The process of socialization, while integral, often functions to uphold hegemonic power, and thus has important implications for practices and policies in the field of graduate education. Hegemonic power is defined as the power that certain classes in society wield over less powerful classes, often in the form of the manipulation of societal norms, values, and language (i.e., soft power; Gramsci, 1971). In our previous work (Weatherton and Schussler, 2021), we discussed how *implicit* definitions of success are likely to benefit groups that are already in power (i.e., people who are white, male, high socioeconomic status), and how students who do not fit into these categories can often have more diverse definitions of success compared with their colleagues, and thus are more likely to feel "othered" by a narrow definition of success. All of the students in this study had extremely diverse definitions of success, and many of our participants expressed that they did not always feel like they belonged in their department or in their fields. These results support previous work that suggests that misalignments in students' definitions can lead to downstream effects on student well-being (Brauer *et al.*, 2021; Weatherton and Schussler, 2021). Our data suggest that advisors and departments must make an effort to understand not only how they are explicitly defining success to graduate students, but also how their departmental culture implicitly condones certain definitions of success, and thus may harm student well-being. We acknowledge, however, that more research on how departments and faculty members define success is needed. Overall, our results suggest that broadening the way that success is viewed within higher education (to include multiple, diverse components of success) is not only important for individual graduate students' sense of belonging and well-being, but it may also be integral to

address systemic structures that function to suppress diversity within the life sciences domain.

Changing Definitions and Metrics over Time

All of the students in our study described some aspect of change in their conceptions of success over time. These changes were in either how students defined success or how students measured success. Only a few students in our study described the latter, where changes occurred in their metrics but not in their definitions. For example, Sal described that at each stage of his career—PhD student, postdoctoral student, professor—his definition of success would stay the same, but the way he measures success would look different. This was conceptually distinct from the idea that definitions themselves changed over time. These results have implications for how advisors discuss goals and success with students, suggesting that students who have unique ways of framing success may need individualized advising, but further research is needed in this area.

When students stated that their definitions of success had changed, the changes often occurred over a relatively long period, for example, over the course of their educational careers. This suggests that students' definitions of success are relatively malleable and that they are influenced by an accumulation of experiences, much like their identities. For example, Scarlet described how her definition of success had evolved from childhood through her undergraduate and graduate experiences, with particular interactions and moments standing out as having a large impact on her definition. These findings are consistent with the work of Limeri and colleagues (2020), which showed that undergraduate students' definitions of intelligence were highly variable and changed over time. This finding has implications for how student success is measured within a research context; our results suggest that success may not be a stable concept and should thus be surveyed accordingly.

For a handful of students, there was a definite moment that forced them to change the way they defined success—these were often moments of perceived failure. For students in high-stakes, competency-based environments (i.e., graduate school), failure often causes stress, anxiety, and other negative mental health effects (Artino *et al.*, 2012; Pekrun and Perry, 2014). For example, after struggling to present her work, losing an advisor, and having a difficult field season, Dahlia felt defeated. She “took a week to have a breakdown” but then came back with new goals and a new way to define success. Dahlia's new definition, like those of other participants' definitions post-failure, was more aligned with her values and felt more “doable” to her. This suggests that failure may be an important part of the process of creating goals and defining success for students and highlights points where students' mental health may be especially fragile. Many scientists cite failure as an essential part of the learning process and of scientific discovery (Firestein, 2015; Simpson and Maltese, 2017; Wylie, 2019). Although failure may be essential to the learning process, that does not make failure *feel* any better; points of failure during a graduate program may be essential times when support from advisors can have an outsized impact on student outcomes (Barnes *et al.*, 2010; Allen *et al.*, 2022). Many students in our study described their trials through failure, but only some of them were able to look back on the process positively. Those who did often cited a strong support network as well as indicators of a growth mind-

set. Thus, while it is inconceivable that graduate students will not face failure during their programs, our results suggest that support during graduate school can improve student outcomes and assist students in achieving success.

Limitations

Our study has several limitations to consider when interpreting these results. In accordance with our analysis method, we purposefully sampled one domain (life sciences) at one university and tried to limit our sample size to fewer than 20 participants. This was done to capture a specific group's perception of the phenomenon in question—success; indeed, IPA studies often try to limit their samples to between 5 and 15 participants in order to find a relatively homogeneous sample, which allows researchers to more finely examine convergence and divergence in participants' experiences (Smith *et al.*, 2009). However, and as our data show, these perceptions are impacted by a number of different factors (e.g., sociocultural background, year in the program); thus, the results from this study do not represent a fully comprehensive list of graduate students' definitions of success or graduate students' viewpoints.

Participation in our study was voluntary and relied on the experiences of graduate students who were currently enrolled in a graduate program. Thus, it is possible that graduate students who left their programs may have different definitions of success or different experiences with success in their programs that were not captured in our study. Furthermore, our sample was made up entirely of students pursuing a PhD degree, and these students were mostly white, female, and domestic. As a result, we caution against the generalizability of our results beyond the specific context of our sample.

Data in this study were collected from October to December 2020, and this aspect of our research design certainly impacted the results. Contextually, there was a global pandemic during our data-collection period, and participants' views may have reflected the anxiety, isolation, and other stressors engendered by this pandemic. For example, isolation during the pandemic may have exacerbated a low sense of belonging, which was a factor present in many of our interviews. We are unable to say how much this context influenced the findings of this study, including those related to students' mental health and their definitions of success.

Finally, our study was limited by our own experiences and biases. We took many steps to address the validity and trustworthiness of our methods (see *Validity*). While we have done our due diligence to explore, understand, and bracket our internal biases as they relate to interpreting data, there will always be limitations inherent to a qualitative study that stem from who is interpreting the data.

Recommendations for Practice, Policy, and Research

This study was exploratory in nature; thus, more research is needed to make any broad claims about graduate students' conceptions of success. However, based on extant literature, we hypothesize that misalignments between graduate students' definitions of success and their perceptions of normative definitions of success within STEM higher education may have cascading impacts on outcomes such as graduate student persistence, progress toward their degrees, and overall mental health (Figure 3). Given our data and these hypothesized

impacts, several recommendations are indicated. We have broken our recommendations down by domain: practice, policy, and research.

Recommendations for Practice. Our results highlight a number of factors that support student success, including external supports like therapists and coping strategies and engaging in hobbies outside graduate school. As part of the academic socialization process, graduate students should be taught how to use positive coping strategies when they encounter challenges to their success (Musgrove *et al.*, 2021).

Given that no two graduate students will likely have the same definition of success, we also recommend that advisors and mentors make space for graduate students to share their unique definitions and experiences. As with reconciling graduate students' multiple roles, we believe that graduate students' multiple definitions of success should be seen as a key strength, not a flaw. This type of "role integration" is likely to have positive cascading impacts on students' productivity, well-being, and ultimately their success within graduate school (Colbeck, 2008; O'Meara *et al.*, 2017). Further, given that our results suggest that participants' feelings of misaligned definitions (in relation to their advisors, department, or field) may be negatively correlated with their sense of belonging and well-being, we recommend that those in power share their own definitions of success with students and discuss how these definitions align. Not only will these conversations allow advisors and mentors to better understand their students' goals, but they can also foster strong feelings of support in graduate students. Finally, as recommended by Cooper and colleagues (2020) in their study of students with depression, we concur that faculty must normalize failure and assist students in developing a growth mindset.

Recommendations for Policy. Results from this study support our previous policy recommendations, such as incorporating broader metrics of success into university evaluation measures and amplifying student voices during the decision-making process (Weatherton and Schussler, 2021). Participants in our study cited many factors that supported their success, and university leaders should consult these results as well as the perceptions of students at their universities to decide where to allocate funding and support. However, we recommend that institutions should broaden their definitions of success based on the perceptions of diverse graduate students, thus shifting power from the more "dominant" party within higher education toward those with less power. Furthermore, faculty members must realize the power that they hold in implicitly socializing graduate students and explore their own biases and preconceptions when it comes to how a field should define success.

Recommendations for Research. Overall, our study indicates that graduate students, as a population, have unique and valuable perspectives. Thus, we recommend that researchers capitalize on this relatively unstudied population and future work should continue to gather graduate students' perceptions. Within this work, researchers should more deeply explore graduate students' perceptions of factors that support their success, as results from these studies can lay the groundwork for practi-

cal intervention programs to reduce student attrition. More research is needed to explore how graduate students' definitions of success vary across demographic and contextual factors, as well as across time. Furthermore, to understand how misalignments in definitions of success emerge, we recommend that more research be done to explore how advisors, faculty members, and departments in life science domains define success. Our results suggest that students' concepts of "success" may not be stable across time; thus, we recommend that future research should investigate how these definitions shift across students' academic careers. Furthermore, we encourage researchers to use a wide array of metrics to measure graduate student success and to ensure that their metrics for success align with the perceptions of their study population. Other interesting avenues of exploration include how students' definitions of success are related to their identities and sense of belonging and how these definitions develop as a process of socialization.

CONCLUSION

This study explored life science graduate students' perceptions of success and their experiences with success in their program. We found that graduate students have multiple, diverse definitions of success that are influenced by a wide range of factors. If students felt that their definitions of success were misaligned with their advisors, department, or institution, this often led to intra- and interpersonal tension. Indeed, graduate students in this study often expressed a perception of definitional misalignment in addition to a low sense of belonging within their fields. Overall, the themes discovered in this study suggest that graduate students' definitions of success are shaped over time, both through their experiences and through the process of professional socialization. Furthermore, our themes suggest that graduate students' definitions of success are a unique part of their identities and that these definitions may be tied to graduate students' well-being, perceptions of their program, and future outcomes. To our knowledge, this is the first study that has gathered graduate students' definitions of success and, as such, lays the foundation for future studies that center student voice and address extant issues related to graduate student mental health and persistence within academia.

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