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Unequal expectations: First-generation and continuing-generation students' anticipated relationships with doctoral advisors in STEM

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Abstract
One of the central goals of doctoral programs is to develop independent researchers and scholars who will lead the next generation of knowledge production. Despite extant evidence of inequalities in doctoral education, few studies have closely examined the experiences of first-generation college students who pursue a Ph.D. We examine how first-generation and continuing-generation doctoral students conceptualize the role of the faculty advisor/principal investigator (PI) in supporting their development as researchers. Our analysis of interviews from 111 first-year Ph.D. students in the biological sciences indicates that first-generation and continuing-generation students had similar overarching conceptions of PIs and the role of PIs in their development. However, the two groups ascribed different meanings to the same concepts. First-generation students expected more direct, skill-based guidance and assistance with learning to do research the "right" way. Conversely, continuing-generation students expected independence and support for their specific needs. We rely on Bourdieu's conceptualization of habitus to explain these differences and conclude by offering implications for advancing equity in doctoral education and supporting first-generation students, particularly regarding the alignment of student–advisor expectations.

Keywords First-generation students · Doctoral education · Mentoring · Socialization · Habitus

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First-generation students[1] represent approximately 30% of doctoral degree recipients in the USA (National Science Foundation [NSF], 2015). While some research has discussed the challenges experienced by first-generation doctoral students (Gardner & Holley, 2011; Holley & Gardner, 2012), few studies have closely examined first-generation students' experiences in graduate education (e.g., see a discussion in Gardner, 2013). In particular, scholars have not considered how first-generation and continuing-generation doctoral students understand their development as independent researchers—a crucial omission, given that becoming an independent researcher is a central goal of doctoral student socialization (Weidman et al., 2001). Without shared understandings of this process, first- and continuing-generation students may experience different (and inequitable) socialization patterns and outcomes.

The present study explores how first-generation and continuing-generation Ph.D. students in US doctoral programs articulate their expectations for faculty advisors' engagement in their development as biological science researchers. Faculty advisors are socialization agents (Weidman et al., 2001) and thus play a central role in how students learn the craft of research, particularly in science, technology, engineering, and mathematics (STEM) fields. It is vital to understand these dynamics within the context of biology graduate training given persistent challenges with diversifying the field, the established links between researcher diversity and innovation, and the importance of biomedical science research to addressing ongoing social and health challenges (Clark & Hurd, 2020; Valantine & Collins, 2015).

Our examination of interviews from 111 first-year Ph.D. students indicates that first-generation and continuing-generation students had similar overarching conceptions of their principal investigators (PIs), who frequently serve as faculty advisors (Maher et al., 2013), and the role of PIs in their development. However, the two groups of students ascribed different meanings to the same concepts. First-generation students expected more direct, skill-based guidance and assistance with learning to do research the "right" way. Conversely, continuing-generation students expected independence and support for their specific needs. Understanding differences across groups is critical to equity in doctoral education, as continuing-generation students' PI expectations seem more closely aligned with faculty expectations of their roles (Lechuga, 2011), leaving first-generation students more likely to be dissatisfied with their PI relationships and limiting first-generation students' access to the benefits these relationships can provide.

Conceptual framework and literature review

This study is situated within a socialization framework (Weidman et al., 2001; Weidman & DeAngelo, 2020), which has been a predominant conceptual lens for studies on US doctoral programs over several decades (Acker & Haque, 2015). Socialization has been widely used to investigate students' navigation of benchmarks that are common to American doctoral education (Gardner, 2008). Although socialization scholars have started to more intentionally engage issues of inequality related to race/ethnicity and gender, they have less frequently attended to first-generation status. Gopaul's (2011) work stands out in this regard, as he articulated a framework for understanding first-generation students' socialization experiences by leveraging Bourdieu's (1977, 1990) concepts of cultural capital and habitus. To situate the

[1] We define "first-generation" as students who come from families in which no parent/guardian completed a bachelor's degree. Students from families where at least one parent/guardian completed a 4-year degree are regarded "continuing-generation."

current study, we first provide an overview of the socialization framework, followed by a discussion of cultural capital and habitus.

Socialization

With respect to graduate and professional students, socialization is broadly understood as the process by which students learn the knowledge, values, and skills that characterize their chosen disciplines and institutional context (Weidman et al., 2001). Socialization traces students' development from an initial anticipatory stage upon entering their doctoral program through formal (e.g., coursework) and informal (e.g., peer mentorship) processes that shape their professional identities (Weidman & DeAngelo, 2020). Within such experiences, researchers have often highlighted how doctoral students rely on their advisors, peers, and other salient relationships to understand their roles and emergent professional identities (e.g., Burt, 2019; Felder et al., 2014; Gardner, 2008). Scholars suggest that this socialization process begins quite early, with students across academic disciplines receiving messages from faculty about the purpose and production of research well before initiating their dissertation projects (Mantai, 2017; Sweitzer, 2009). In the USA, the first two years of doctoral study in STEM resemble master's programs in Europe and Canada, as trainees take classes, have experiences in multiple laboratories before selecting a mentor, complete comprehensive exams, and begin their independent research projects (Barnett et al., 2017). Understanding first-year students' expectations about the help and support they will receive as emerging researchers is important, as expectations can guide both the quality of future interactions and doctoral students' satisfaction with their training experiences and relationships (Young & Perrewé, 2004).

In STEM fields—especially those that rely on laboratory research groups—doctoral socialization experiences hinge on students' relationships with their PI. Indeed, STEM doctoral students' relationships with their faculty advisors underscore their skill- and career-related developmental trajectories (Blaney et al., 2020) and their persistence decisions (Maher et al., 2020a). Yet despite extant research documenting the faculty advisor's important role in doctoral student development, few studies have investigated students' early expectations for a faculty advisor's role in the socialization process.

In addition, scholars have recently amplified the importance of students' social identities in socialization processes, which—for example—has resulted in expanded research on the gendered nature of doctoral socialization (e.g., Sallee, 2011; Wofford & Blaney, 2021) and the importance of centering doctoral students' racial and ethnic identities in understanding their socialization experiences (e.g., Griffin et al., 2020; Twale et al., 2016). Fewer studies, however, have examined the doctoral socialization experiences of first-generation students (see a discussion in Gardner, 2013). While recent scholarship has extended the socialization framework to engage some of the structural challenges that may constrain opportunities for individuals with marginalized identities, this framework does not fully engage the unique barriers that first-generation students may face. To address this, we turn to the concepts of cultural capital and habitus.

Cultural capital, habitus, and first-generation status

Cultural capital was first conceptualized as specific linguistic and cultural competencies (Bourdieu, 1973; Bourdieu & Passeron, 1977) but was extended in subsequent educational research to reflect familiarity with expectations, norms, and procedures of social institutions (see a review in Lareau & Weininger, 2003). As a complementary element to how Bourdieu

conceptualized the role of culture in reproducing social inequality, habitus reflects deeply internalized dispositions that generate "thoughts, perceptions, expressions, and actions" (Bourdieu, 1990, p. 55). In other words, habitus represents individuals' internalization of social structures, reflecting perceptions and attitudes that shape their actions. In educational research, habitus has often been operationalized through students' expectations and dispositions to engage in particular ways with their educational settings.

Although commonly used in higher education to understand inequality among undergraduate students from different socioeconomic groups (e.g., Armstrong & Hamilton, 2013; Collier & Morgan, 2008; Jack, 2019; Stuber, 2011), cultural capital and habitus are less frequently considered within doctoral education. Gopaul (2011) has done the most significant work to explicate how cultural capital and habitus generate inequality in graduate education. In particular, he highlighted the role of habitus in students' ability to navigate the field of doctoral study. Since habitus represents one's perceptions and attitudes that frame possible modes of action, it can have important implications for students' ability to cultivate relationships with faculty and peers. In subsequent work, Gopaul (2015, 2016) noted a lack of clarity in several areas of doctoral education, which placed advisors in a central role of helping to "decode" expectations. This simultaneously makes advisors key agents of socialization, as others have noted (Barnes & Austin, 2009; Noy & Ray, 2012), and raises concerns about the consequences of potential disconnects in expectations between graduate students and their advisors.

Other emergent literature on first-generation doctoral students has similarly attributed observed differences between first-generation and continuing-generation students to cultural capital and habitus (e.g., Gardner & Holley, 2011; Holley & Gardner, 2012). In their qualitative study, Gardner and Holley interviewed 20 first-generation Ph.D. students at varying stages of doctoral training and across a range of disciplines. Despite participants attending two institutions that award a high proportion of doctoral degrees to first-generation students, these students often did not know the "unspoken" rules and experienced challenges navigating their Ph.D. programs. As such, participants noted that "success" required a copious amount of tacit knowledge about how higher education institutions operate. First-generation students noticed that their peers seemed to "understand the rules of the game… [while they felt] 'clueless' or 'in the dark' about what was expected or how to navigate the system" (Gardner & Holley, 2011, p. 84).

In the present study, we extend prior literature by focusing on the early stages of socialization. Specifically, we explore students' expectations regarding the role of a faculty advisor in their development as an independent researcher in the biological sciences. While some scholars have described the socialization experiences of first-generation and continuing-generation doctoral students (e.g., Gardner & Holley, 2011; Gopaul, 2015, 2016; Roksa et al., 2018), studies have sparsely considered how students make meaning of their expectations during the early stages of doctoral training. To address this gap, we ask: what do first-year doctoral students expect regarding faculty advisors' role in fostering their research development, and how do students' expectations for their advisors vary between first-generation and continuing-generation students? By focusing on doctoral students' early expectations, we offer critical insight into how first-generation and continuing-generation students understand doctoral education.

Methods

Given extant research on undergraduate students (Collier & Morgan, 2008; Kim & Sax, 2009), and how access to class-based information and resources can shape expectations and

socialization into graduate school (Gardner & Holley, 2011; Gopaul, 2015, 2016; Holley & Gardner, 2012), first-generation students are likely to enter doctoral education with different expectations of their PIs than their continuing-generation peers. In light of our interest in understanding not only what students' expectations of faculty were but how expectations formed and what meaning and implications they had for graduate students' experiences, we chose to engage in qualitative methods (Bogdan & Biklen, 2007). We approached the present work with a constructivist lens to foreground how "reality is constructed in the mind of the individual, rather than it being an externally singular entity" (Ponterotto, 2005, p. 129).

The research is guided by a generic qualitative approach (Caelli et al., 2003; Kahlke, 2014), which allows for the integration of multiple methodological strategies in an effort to understand distinctions in students' expectations. For this study, we relied on interviews as the main source of data. Consistent with a generic qualitative approach, our data collection and analysis was informed by theories (Caelli et al., 2003)—in this case, socialization, habitus, and cultural capital. However, our interpretations of the data are largely inductive, and a generic approach allowed us to balance data-informed descriptions of students' expectations drawn from their interviews with our interpretations of how first- or continuing-generation status may have influenced observed differences. Further, given that people create shared understandings of reality through interactions, which are often expressed through the language used to describe experiences (Berger & Luckmann, 1966), our epistemological and methodological strategies are aligned. Thus, we focus not only on the expectations that participants communicated but how students used and adapted words and their meanings to describe their anticipated relationships with faculty.

Study participants and data collection

We drew participants from a larger, longitudinal, mixed-methods project of 336 biological sciences Ph.D. students across 53 universities with high research activity who began doctoral programs in fall 2014 (http://ecr.usu.edu/).[2] To recruit participants, we contacted program directors and department chairs of the 100 largest biological sciences doctoral programs in the USA, describing the study and asking that they inform incoming Ph.D. students about the research project. To diversify the prospective pool of participants, we subsequently contacted all public flagship universities (research intensive), historically Black colleges and universities (HBCUs), and Hispanic-serving institutions (HSIs) offering Ph.D. programs in appropriate biology subfields. Further, emails describing the study and eligibility criteria (incoming doctoral students in biological sciences) were sent to several listservs, including those of the American Society for Cell Biology and the CIRTL (Center for the Integration of Research, Teaching, and Learning) Network for broader dissemination.

In addition to completing regular surveys, a subsample of the 336 original respondents participated in annual in-depth interviews with a member of the research team. Given the project's emphasis on inequities by first-generation status and race/ethnicity, the original interview sample included all individuals in the larger sample who identified as first-generation or as racially/ethnically minoritized[3] and attended an institution that had at least

[2] More specifically, the study focused on "bench biology" — US doctoral programs in fields including microbiology, cellular and molecular biology, genetics, and developmental biology.

[3] We define racially/ethnically minoritized groups as students who identify as American Indian or Alaska Native; Black or African American; Latina/o/x; Native Hawaiian; or Pacific Islander.

one participant who identified as belonging to a racially/ethnically minoritized group. In addition, a similar number of students not belonging to those categories (i.e., first-generation or racially/ethnically minoritized group) from each institution were invited to participate.

For this study, data were drawn from interviews with doctoral students near the end of their first year of graduate school. Research team members completed these interviews over approximately three months (January through March 2015). Among interview participants (n = 143), we selected a subset of first-year Ph.D. students who participated in lab rotations (n = 111) in the 2014–2015 academic years. We focused on the experiences of students who completed rotations (i.e., where first-year students spend a short amount of time, usually 7–10 weeks, in a lab and often repeat this experience across 2–3 labs), given their importance in setting the stage for doctoral training and selecting a PI (Maher et al., 2019, 2020b). In principle, rotations allow new students to test different labs and advisors in search of the best match (Maher et al., 2019).

First-generation students accounted for 37% (n = 41) of this sample, while continuing-generation students made up the remaining 63% (n = 70), which closely resembles percentages of first-generation students in the broader sample as well as national datasets (NSF, 2015). See Table 1 for a description of participants.

All participants engaged in 30–60 min, one-on-one, semi-structured telephone interviews. The interview protocol included questions about students' pathways to the Ph.D., past and current research experiences, expectations of PI/faculty advisor roles, and presence of other support systems. All interviews were recorded and transcribed verbatim. After transcription, data were redacted, removing all personal and identifying information. Participants and their institutions were assigned pseudonyms, which we use throughout this manuscript.

Analysis

We analyzed data through a multiphase collaborative process that balanced inductive and deductive strategies. After interviews were transcribed, cleaned, and redacted, the transcripts were uploaded to Dedoose qualitative software. In the first phase of data analysis, the first author independently reviewed transcripts from 15 first-generation and 15 continuing-generation students who completed first-year rotations, using In Vivo coding to construct a

Table 1 Description of participants (n = 111)

	Percent within group	Percent among all
First-generation students (n = 41)		
Racially/ethnically minoritized women (n = 11)	26.8	9.9
Racially/ethnically minoritized men (n = 4)	9.8	3.7
White, Asian, or Asian American women (n = 12)	29.3	10.8
White, Asian, or Asian American men (n = 14)	34.1	12.6
Continuing-generation students (n = 70)		
Racially/ethnically minoritized women (n = 9)	12.9	8.1
Racially/ethnically minoritized men (n = 9)	12.9	8.1
White, Asian, or Asian American women (n = 38)	54.2	34.2
White, Asian, or Asian American men (n = 14)	20.0	12.6

Notes. While definitions in the literature vary, we define first-generation students as those who come from families in which no parent or guardian completed a bachelor's degree. Additionally, although aggregated groups provide an overview of first- and continuing-generation students' gender and racial/ethnic identities, we acknowledge that racialized and gendered experiences vary in more nuanced ways than presented here

working codebook (Saldaña, 2016). The authors of this work then met to discuss the preliminary inductive codes, as well as emerging interpretations of differences in experiences and expectations across groups.

In the second phase of data analysis, the first author pulled participants' responses for three specific questions to focus our attention on students' perceived role of the PI: "What is the role of a faculty advisor in a Ph.D. program?", "What expectations do you have for a faculty Ph.D. advisor?", and "What are these expectations based on?" Each of the authors independently read all excerpts and drafted detailed analytic memos to understand, compare, and contrast how students described their experiences and expectations. Memos also helped explicate observed nuances in the data, such as how students used similar language but ascribed varying meanings to the same words. Memos were discussed and used to revise the existing codebook, adding more inductive codes drawn from the data, as well as deductive codes based on extant socialization literature.

In the third phase of data analysis, the first and second authors used the revised codebook to analyze all 111 participants' responses to the three aforementioned protocol questions. In addition to applying the revised codes, the first and second authors noted keywords, phrases, and metaphors utilized in each participant's responses. Language serves social functions, and not only what but how ideas are presented matters (Fairclough, 2001). After codes were applied, the first and second authors met again to discuss code assignments and congruence as well as salient ideas within and across themes. The first author then consolidated the work and used code reports, memos, and notes from previous discussions of the data to generate a draft of the findings, which was discussed collaboratively by the authors of this work, confirming the accuracy of interpretations and considering any disconfirming data.

Positionality and trustworthiness

Our team employed multiple strategies to increase the trustworthiness of this research. We were mindful of our identities, values, and commitments to graduate education as we engaged in the research process, noting our positions as insiders and outsiders in the research process. The first author identifies as a continuing-generation white woman, has administrative experience in graduate admissions, and has studied equity in pathways to and within STEM doctoral education. The second author identifies as a continuing-generation Black woman who has worked as an administrator and studied equity and mentoring in higher education and STEM graduate education specifically. The third author identifies as a first-generation white woman whose research and administrative work focuses on understanding experiences of populations traditionally underserved in higher education in general and STEM in particular. Our identities and experiences as scholars and practitioners in STEM environments led to our interest in this topic and our ability to make meaning of subtle differences between participants' narratives. However, we were also individually and collectively mindful of our positionalities and how our perspectives could lead to assumptions about what is understood about mentoring and faculty interactions, students' expectations, and the experiences of marginalized and minoritized populations. We were also mindful of our identities as disciplinary outsiders and our assumptions about STEM education.

Throughout our process, the research team met frequently not only to discuss emerging themes and ideas but to challenge and discuss with one another how we knew what we knew, as well as how our identities and experiences could shape our interpretation of the data. Further, engaging in team-based research with multiple researchers and regular peer debriefing

sessions allowed us to enhance the credibility of the study and enhanced our confidence in our analysis and interpretations of the data.

Limitations

Although offering key insights to prior literature, several limitations are notable. First, while we acknowledge first- and continuing-generation students' gender and racial/ethnic identities in this study, we did not set out to comprehensively discuss within-group variation when students had multiple marginalized identities. This is an important area for future research. Further, these results may not speak to first- and continuing-generation students' experiences at institutions beyond those with very high research activity. Future research might consider using samples from a range of institutional types, as the pressure for productivity at research-intensive institutions may affect students' perceptions of their PIs. Finally, given the unique context of scientific labs, it is vital to note that these dynamics may manifest differently in disciplines without such a central focus on lab work.

Findings

We examined how biological sciences doctoral students' expectations of their faculty advisors varied between first-generation and continuing-generation students, particularly as they navigated their early development as researchers. Ultimately, while first- and continuing-generation students stated similar expectations for their PIs, the meanings that students ascribed to these expectations varied in ways that could have implications for relationship quality and student success. We begin by illustrating similarities, followed by differences. Throughout the findings, we highlight first- and continuing-generation students' voices side by side to allow for a more direct comparison across similar themes.

Similarities in expectations

PI–student relationships are a signature feature of doctoral training (Lee, 2008), and the participants in our study were highly aware that their faculty advisor relationships were critical to becoming successful researchers. The majority of participants (whether first- or continuing-generation students) based advisor expectations on similar prior experiences, drawing from past research experiences and observing how PIs interacted with their peers. Consequently, students articulated similar expectations about wanting a PI to support their development by providing intellectual support and being accessible and available for guidance and direction.

Intellectual support

First-generation and continuing-generation students similarly expected their advisors to provide intellectual support and help them engage in the craft of research. Participants acknowledged the vast experience of their PIs, largely expecting PIs to provide intellectual support by guiding their projects and shaping how they thought about their current and future research projects. For example, Jett, a white, first-generation man, recalled:

> I think it's gonna have to be someone who is going to teach me how to properly carry out the scientific method . . . how to ask the right questions about my research . . . I want someone who's definitely going to be able to communicate that with me and teach me how to begin to think about what's the next step or how we conduct research.

In this example, Jett emphasized wanting a PI who would help him understand the process of science and communicate the logic of devising research questions in a developmental way. Selena, a white, continuing-generation woman, conveyed similar expectations about wanting an advisor to provide intellectual support and insight about the scientific process. She described this support by saying, "I would like someone who's able to encourage me to think by myself and just [think] in that way as I develop the skills you would need to be a scientist." Like Jett and Selena, other students expected their PI to play an instrumental role in helping them learn how to think through questions and leverage this knowledge to become an independent researcher.

Access and availability

In addition to intellectual support, first- and continuing-generation participants similarly articulated expectations about PI access and availability. Many students reflected that it was critical for their advisor to be easily accessible or available when they needed them. Participants often expected their PI to be physically or virtually present, and some students seemed to use faculty presence as a barometer of how invested the PI was in their doctoral experience and development. For example, Anastasia, a first-generation woman who identified as Black and white, stated, "I want someone who is easy to contact . . . [who is] interested in doing—being in the lab still." Here, Anastasia emphasized PI availability by discussing how she wanted a PI that felt compelled to be in the lab and engage in the science. Jane, a continuing-generation Black woman, more directly discussed wanting a PI that was accessible for her disciplinary development as well as her individual development by stating:

> I expect that person to be available when I need them. That doesn't mean that I have to see them every day, but . . . I want them to be engaged in the project . . . and certainly engaged with me and my progression….

The connections that Anastasia and Jane made between their expectations of PI interest, accessibility, and availability were also discussed by several of their peers and represented shared expectations across students' generational backgrounds.

Differences in meaning making of advisor expectations

While first-generation and continuing-generation students identified similar expectations in terms of PI availability and support, the meanings behind students' stated expectations diverged significantly. Notably, participants offered contrasting meanings of their advisor expectations in terms of cultivating their ability to develop as independent researchers. First-generation students emphasized the PI's role in teaching them the "right" way to think, while continuing-generation students more often expected their PI to foster independence and keep them from veering too far off course. Further, participants differed in how they expected their PIs to be involved. First-generation students expected holistic advisors who were more directive in the lab, but continuing-generation students expected PIs to support their individual needs as emerging researchers and be less directive.

Thinking like an independent researcher

First-generation students As they articulated how they anticipated advisors would help them learn to become independent think it's gonna have to Further, Leslie, an Asian woman, stated that the PI should "advise you on—I guess like . . . at least first set guidelines on your research [and] give you information and advice on how to make a good experiment…." A white woman named Layla similarly noted, "I mean, if you come across this stumbling block, they're basically, they're the expert in the field and you'd just go to them and have a discussion about it. They can set you in the right direction." The concept of advisors being able to "set" or "lead" students in the right direction was a recurring way that first-generation students used specific language to talk about how their PI might impact their development. For Nigel, Leslie, Layla, and several of their first-generation peers, learning how to think like an independent researcher was defined by expecting their advisor to tell them the right experiment to do or the right way to do research.

In addition, when discussing the learning process associated with their development as independent researchers, first-generation students uniquely hoped that their PIs would not be frustrated or angry when roadblocks came up. A white man named Donovan stated, "I hope he'll be understanding. I hope he won't get mad when some things don't work. I'm sure things will not work in science, because that's the nature of the beast, I guess." Further, a white woman named Ingrid said,

> Well, I would expect for them to be understanding of me . . . if something doesn't work out the way that it should . . . I would expect them to teach me the right way of doing science and the right way to get where I want to go.

In these and other examples, it became clear that first-generation students wanted direction on how to do science in the "right" way, and they hoped that mistakes would be viewed with grace.

Continuing-generation students Conversely, continuing-generation students described "thinking" more analytically, focusing on how to think about research and make independent decisions. Luis, a Latino and white man, noted, "The point of grad school is really coming here and trying to think like a scientist. For me the PI's only job is to teach you . . . how to think about problems." Continuing-generation students also articulated how PIs might guide them to "grow," "work independently," and gain autonomy. For example, Hazel, a white woman, expected her advisor to "sort of lead you into better research practices . . . [and] conduct yourself in a way that is conducive to critical thinking." A Black man named Quinton similarly expected his advisor to direct him "to become a more critical thinker and ask better questions about science and things like that." Here, it is noteworthy that Quinton anticipated developing his research questions independently while soliciting feedback from his PI to grow in the process of working and thinking independently.

Although continuing-generation students noted that they may make mistakes, the consequences of mistakes were viewed differently than their first-generation peers. Rather than wanting their PI to provide grace, continuing-generation students saw mistakes as an opportunity for growth. For example, Amanda, a white woman, recognized that the ways her advisor provided intellectual support might deliberately include failures. Here, she said, "Even if that means you [the PI] have to watch a student fail, because [you] know it's a bad idea, you need your student to learn and grow as a scientist and learn how to think through an experiment."

Further, when continuing-generation students did fail or struggle, they wanted to make sure that they were not veering too far off course. Continuing-generation students often described "direction" as a reconfiguring process, wanting their PI to step in if they were off track—which stands in contrast to first-generation students' language of being on the "right" track. Swati, an Asian woman, illustrated this by saying, "Basically if I ever do get off track, to just kind of be like—they kind of steer me back…." Similarly, Lorenzo, a Latino man, shared,

> I feel like I have enough experience under my belt that I can work independently, but if I am lost or confused, I can go to that person and say, "Am I on the right track? . . . And if not, where would you go?"

Swati and Lorenzo's expectations of using their advisor as a sounding board for guidance toward independence were shared by several of their continuing-generation peers. Not only does this reflect a sense of independence in continuing-generation students' research competence but it also reflects the notion that they viewed "struggle" as a natural part of their development.

PI involvement in student development

First-generation students First-generation students used action-oriented language (e.g., "set," "lead" in a certain direction) and expected a more active role from their PI, especially in terms of the day-to-day science. Many first-generation students also expected their advisor to be an affirming voice in their development. For example, Marcus, a Black man, said that a PI should be an individual who demonstrates "an interest in students and wants to see them grow, even if they might not be the best technician . . . They have a true interest in the student." Akin to the ways in which Marcus discussed both intellectual and personal support from his advisor support, a white man named Jackson said,

> I think their job is to guide you, and mentor you, and lead you, obviously, in a manner to be a successful scientist . . . Not only should they mentor you and guide you, but also they should . . . be somewhat of a friend and generally build a relationship . . . that leaves them the teacher, I guess.

Above, Marcus and Jackson related how they expected the PI to shape their professional and personal lives. Further, the ways that Jackson anticipated his advisor to have a direct teaching role throughout his trajectory illustrates how first-generation students saw the onus for teaching to be placed on the PI. This perspective was shared by Leonard, a first-generation white man, who said "their [the PI's] main goal, really, is to teach you how to be them. To teach you how to be somebody who can run a lab, who can create their own experiments." Here, Leonard elaborated on how the PI should know when and how to teach students the ways to be an independent researcher. Overall, many first-generation students conveyed that faculty advisors should inherently know how to cater guidance to students' needs.

Continuing-generation students In contrast, continuing-generation students viewed PIs as having a less direct teaching role. Charlotte, a continuing-generation white woman, discussed that—at first—the PI should help her understand the research of the lab and how to ask relevant questions, but she acknowledged that this would change, stating, "He's always there if I need him, but he lets me kind of have the reins after I feel comfortable." Likewise, other continuing-generation students were acutely aware of the long-term benefits that independent

learning would provide, with the faculty advisor playing more of a distal role in direction and guidance over time. Ultimately, continuing-generation participants noted how this type of advisor involvement could "make you a better scientist and to prepare you for the future that you want…" (Violeta, a Latina woman) and help students "know how to be more confident" (Francisco, a Latino man). For Evan, a white man, this was the process of becoming a "self-directed scientist."

Additionally, the continuing-generation students in our study believed in the power of student agency when it came to the role of the advisor. In relation to this, Antonia, a woman who identified as Latina and white, said, "I guess ideally for me I would like them [the PI] to be more willing to let the student direct the focus of the research." As such, she believed students should be able to decide how they want to be guided. This outlook was shared by several of Antonia's continuing-generation peers when discussing how they expected PIs to adjust their guidance to the students' needs and progress.

Overall, Wen, who identified as a continuing-generation Asian woman, summed up the differences in advisor expectations nicely by saying,

> Well, I think it [the role of the PI] depends on the individual person because some people want their PI to teach them directly and other people want them to . . . teach them scientific thought, like the thought process that they go through. I am a little bit more independent than some people, and so I don't want a PI that's gonna be constantly next to me telling me exactly what to do. I'd much prefer one that will discuss the scientific question with you, propose a few experiments, and not tell you exactly what to do cause I wanna be able to learn how to think it for myself essentially. A good PI would be one that would allow you to think for yourself or ask the right questions to get you to that point.

While Wen and other continuing-generation students readily saw the benefits in learning how to think without extensive involvement from their advisor, first-generation students often expected to develop a more personal, direct relationship that would provide them with assurance that they were doing well.

Discussion

Although many scholars have documented the central role of faculty advisors in doctoral students' socialization process, prior research has not dedicated much attention to understanding how students' expectations for their advisor's role differ between first-generation and continuing-generation students. We address this gap in the literature by analyzing interview data from 111 Ph.D. students in the biological sciences. Our findings indicate that students drew expectations from similar prior experiences and, overall, stated a desire for similar types of support from their advisors. However, what first-generation and continuing-generation students meant by these expectations differed, with first-generation students expecting much more direct, skill-based guidance and continuing-generation students focusing on independence and support for their specific needs.

These findings both complement and extend prior work on socialization (Weidman et al., 2001; Weidman & DeAngelo, 2020). Our findings confirm that doctoral students view their faculty advisors as important resources in the process of becoming independent researchers, but first- and continuing-generation students diverged in the specific ways that they expected

faculty to support them in this process. The first salient distinction lies in the level of direction that students expected from their PIs. Overall, first-generation students expected advisors to concretely teach them how to do research, whereas continuing-generation students expected advisors to help them think like researchers in a less directed way. Second, first-generation students articulated a personal PI-student relationship as more holistic, expecting the PI to be interested in their life outside of academe and provide support in a kind, caring way, while continuing-generation students described a personal relationship as an individualized one; they expected their advisor to provide guidance (in a more purely professional way) that catered to their individual trajectories and needs.

Several prior studies have relied on concepts of cultural capital and habitus to describe first-generation students' experiences in doctoral education (e.g., Gardner & Holley, 2011; Gopaul, 2015, 2016). Our findings illuminate the importance of early expectations in setting the stage for the different understandings first- and continuing-generation students develop in doctoral education. Expectations reflect an individual's understanding of the world and represent an important dimension of habitus. Habitus is rooted in one's early socialization experiences and, particularly, in one's socioeconomic background (Bourdieu, 1990). Scholars have documented that educational socialization in more socioeconomically advantaged families is aligned with the expectations of teachers and educational institutions more broadly (Jack, 2019; Lareau & Weininger, 2003). In the context of the present study, if habitus underlies the differences between first- and continuing-generation students, we would predict that the expectations of continuing-generation students in doctoral education are more closely aligned with those of faculty.

Our findings imply that, indeed, habitus helps explain the distinction between first- and continuing-generation students' expectations for both research and faculty–student relationships. Concerning researcher development in STEM doctoral education, continuing-generation students are more aware that academic freedom and learning how to think creatively, problem solve, and trouble shoot independently are embedded parts of their training, which aligns with research on faculty expectations of graduate students' performance (Lechuga, 2011). Further, while research suggests that advisors see their faculty–student relationship as one where they are ambassadors to the scientific profession (Lechuga, 2011), continuing-generation students are more aware of how advisors can help establish their legitimacy and broader recognition as researchers than their first-generation peers.

In addition, expectations regarding PI relationships suggest greater congruence between continuing-generation students and faculty. Faculty are not often socialized to recognize personal support as critical to developmental relationships (O'Meara et al., 2013), shaping PIs' expectations of the level of personal support offered in faculty–student relationships. While research on graduate students with marginalized identities more generally suggests that they often seek social and emotional connection (Felder et al., 2014; Gardner, 2008; Griffin et al., 2020; Patton, 2009), science faculty may de-emphasize social and emotional dimensions of academic training (Anderson & Louis, 1994) and be less available or interested in the provision of psychosocial support (Curtin et al., 2016).

Implications

These differences not only contribute to expanding the research on doctoral socialization to account for habitus but also have notable implications for practice. Graduate education in the USA is a particularly important context to study, as the USA is the highest producer of advanced degrees in science and engineering, and US degree programs continue to attract and enroll

trainees from all over the world (National Science Board & National Science Foundation, 2020). Given that the first two years of most US doctoral programs are similar in structure and goals to master's programs in Europe and Canada (Barnett et al., 2017), these findings may be best thought of as applicable to the experiences of students early in their science training rather than focusing on whether they are enrolled in a doctoral or master's program.

The National Academies of Science, Engineering, and Medicine (2019) describe mentorship as a bidirectional relationship that requires explicit discussions of expectations between both mentors and mentees. Given that continuing-generation students articulate their expectations in more concrete ways—and in ways more aligned with what faculty inherently expect of students' independence—there is a need for advisors and doctoral students (especially first-generation students) to have intentional conversations about their expectations (see Lechuga, 2011). It is also crucial for advisors to consider how their own background as a first- or continuing-generation student shapes their assumptions about how to be a faculty advisor, and future research should explore how shared or divergent generational identities shape faculty–student relationships. Further, the meanings that first- and continuing-generation doctoral students ascribe to faculty expectations might be more similar if faculty emphasize the role of disciplinary knowledge and student-directed research among first-generation doctoral advisees.

While faculty advisors can alter their approaches individually, these findings also suggest the need for structural change to support equitable doctoral experiences for first-generation students. Institutions should offer training to help faculty members explicate the informal knowledge, processes, and norms that lead to graduate student success (see Calarco, 2020). Doctoral programs may also do well to provide information to first-generation students about how their relationships with faculty advisors can evolve over time, as continuing-generation students in our study were much more familiar with this evolution toward becoming an independent researcher and how this might change throughout their training. Finally, doctoral programs may consider hiring staff to partner with faculty and coordinate centralized resources for first-generation students.

Addressing disconnects between first- and continuing-generation students' expectations of faculty advisors is crucial, as a misalignment in expectations can lead to dissatisfaction and conflict, interfering with the learning and development that could potentially take place (Griffin et al., 2020; Schlosser et al., 2003). Gopaul (2015, 2016) has described how the socialization process and faculty mentoring can reproduce inequalities, and other recent work has documented how faculty messages about scientific norms and values shape women's doctoral and postdoctoral pathways in biomedical sciences (Griffin et al., 2015). Our findings illuminate how these processes differ between first-generation and continuing-generation students. The disconnects between the "rules of the game," faculty expectations, and first-generation doctoral students may prompt these students to leave their programs or be less satisfied. At the very least, such misalignments can lead to tensions and unproductive faculty–student relationships. Ultimately, attending to the differences in how students perceive and make meaning of their advisor's role is important for creating equitable graduate training experiences for first-generation and continuing-generation students.

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References

Acker, S., & Haque, E. (2015). The struggle to make sense of doctoral study. *Higher Education Research & Development, 34*(2), 229–241.

Anderson, M. S., & Louis, K. S. (1994). The graduate student experience and subscription to the norms of science. *Research in Higher Education, 35*(3), 273–299.

Armstrong, E. A., & Hamilton, L. T. (2013). *Paying for the party*. Harvard University Press.

Barnes, B. J., & Austin, A. E. (2009). The role of doctoral advisors: A look at advising from the advisor's perspective. *Innovative Higher Education, 33*(5), 297–315.

Barnett, J. V., Harris, R. A., & Mulvany, M. J. (2017). A comparison of best practices for doctoral training in Europe and North America. *FEBS Open Bio, 7*(10), 1444–1452.

Berger, P. L., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge*. Penguin Books.

Blaney, J. M., Wofford, A. M., Jeong, S., Kang, J., & Feldon, D. F. (2020, April 17-21*). How STEM doctoral students make meaning of their academic and professional trajectories: A narrative analysis* [Paper presentation]. American Educational Research Association Annual Meeting, San Francisco, CA, United States http://tinyurl.com/ut62xqh (Conference canceled).

Bogdan, R., & Biklen, S. K. (2007). *Qualitative research for education: an introduction to theories and methods* (5th ed.) Pearson A & B.

Bourdieu, P. (1973). Cultural reproduction and social reproduction. In R. Brown (Ed.), *Knowledge, education and cultural change (pp. 71-112)*. Tavistock.

Bourdieu, P. (1990). *The logic of practice*. Stanford University Press.

Bourdieu, P., & Passeron, J.-C. (1977). *Reproduction in education, society and culture*. Sage.

Burt, B. A. (2019). Toward a theory of engineering professorial intentions: The role of research group experiences. *American Educational Research Journal, 56*(2), 289–332.

Caelli, K., Ray, L., & Mill, J. (2003). "Clear as mud": Toward greater clarity in generic qualitative research. *International Journal of Qualitative Methods, 2*(2), 1–13.

Calarco, J. M. (2020). *A field guide to grad school: Uncovering the hidden curriculum*. Princeton University Press.

Clark, U. S., & Hurd, Y. L. (2020). Addressing racism and disparities in the biomedical sciences. *Nature Human Behaviour, 4*(8), 774–777.

Collier, P. J., & Morgan, D. L. (2008). "Is that paper really due today?": Differences in first-generation and traditional college students' understandings of faculty expectations. *Higher Education, 55*(4), 425–446.

Curtin, N., Malley, J., & Stewart, A. J. (2016). Mentoring the next generation of faculty: Supporting academic career aspirations among doctoral students. *Research in Higher Education, 57*, 714–738.

Fairclough, N. (2001). Critical discourse analysis as a method in social scientific research. In R. Wodak & M. Meyer (Eds.), *Methods of critical discourse analysis* (pp. 122–138). Sage.

Felder, P. P., Stevenson, H. C., & Gasman, M. (2014). Understanding race in doctoral student socialization. *International Journal of Doctoral Studies, 9*(19), 21–42.

Gardner, S. K. (2008). Fitting the mold of graduate school: A qualitative study of socialization in doctoral education. *Innovative Higher Education, 33*(2), 125–138.

Gardner, S. K. (2013). The challenges of first-generation doctoral students. *New Directions for Higher Education, 2013*(163), 43–54.

Gardner, S. K., & Holley, K. A. (2011). "Those invisible barriers are real": The progression of first-generation students through doctoral education. *Equity & Excellence in Education, 44*(1), 77–92.

Gopaul, B. (2011). Distinction in doctoral education: Using Bourdieu's tools to assess the socialization of doctoral students. *Equity & Excellence in Education, 44*(1), 10–21.

Gopaul, B. (2015). Inequality and doctoral education: Exploring the "rules" of doctoral study through Bourdieu's notion of field. *Higher Education, 70*(1), 73–88.

Gopaul, B. (2016). Applying cultural capital and field to doctoral student socialization. *International Journal for Researcher Development, 7*(1), 46–62.

Griffin, K., Gibbs Jr., K. D., Bennett, J., Staples, C., & Robinson, T. (2015). "Respect me for my science": A Bourdieuian analysis of women scientists' interactions with faculty and socialization into science. *Journal of Women and Minorities in Science and Engineering, 21*(2), 159–179.

Griffin, K. A., Baker, V. L., & O'Meara, K. (2020). Doing, caring, and being: "Good" mentoring and its role in the socialization of graduate students of color in STEM. In J. C. Weidman & L. DeAngelo (Eds.), *Socialization in higher education and the early career: Theory, research, and application* (pp. 223–239). Springer.

Holley, K. A., & Gardner, S. (2012). Navigating the pipeline: How socio-cultural influences impact first-generation doctoral students. *Journal of Diversity in Higher Education, 5*(2), 112–121.

Jack, A. A. (2019). *The privileged poor: How elite colleges are failing disadvantaged students*. Harvard University Press.
Kahlke, R. M. (2014). Generic qualitative approaches: Pitfalls and benefits of methodological mixology. *International Journal of Qualitative Methods, 13*(1), 37–52.
Kim, Y. K., & Sax, L. J. (2009). Student–faculty interaction in research universities: Differences by student gender, race, social class, and first-generation status. *Research in Higher Education, 50*(5), 437–459.
Lareau, A., & Weininger, E. B. (2003). Cultural capital in educational research: A critical assessment. *Theory and Society, 32*, 567–606.
Lechuga, V. M. (2011). Faculty-graduate student mentoring relationships: Mentors' perceived roles and responsibilities. *Higher Education, 62*(6), 757–771.
Lee, A. (2008). How are doctoral students supervised? Concepts of doctoral research supervision. *Studies in Higher Education, 33*(3), 267–281.
Maher, M. A., Gilmore, J. A., Feldon, D. F., & Davis, T. E. (2013). Cognitive apprenticeship and the supervision of science and engineering research assistants. *Journal of Research Practice*, *9*(2), Article M5.
Maher, M. A., Wofford, A. M., Roksa, J., & Feldon, D. F. (2019). Doctoral student experiences in biological sciences laboratory rotations. *Studies in Graduate and Postdoctoral Education, 10*(1), 69–82.
Maher, M. A., Wofford, A. M., Roksa, J., & Feldon, D. F. (2020a). Exploring early exits: Doctoral attrition in the biomedical sciences. *Journal of College Student Retention: Research, Theory & Practice, 22*(2), 205–226. https://doi.org/10.1177/1521025117736871.
Maher, M. A., Wofford, A. M., Roksa, J., & Feldon, D. F. (2020b). Finding a fit: Biological science doctoral students' selection of a principal investigator and research laboratory. *CBE—Life Sciences Education, 19*(3), Article 31.
Mantai, L. (2017). Feeling like a researcher: Experiences of early doctoral students in Australia. *Studies in Higher Education, 42*(4), 636–650.
National Academies of Science, Engineering, and Medicine. (2019). *The science of effective mentorship in STEMM*. The National Academies Press.
National Science Board & National Science Foundation. (2020). *Science and engineering indicators 2020: The state of U.S. science and engineering.* Alexandria, VA: Author.
National Science Foundation. (2015). *Doctorate recipients from U.S. universities.* Washington, DC: Author.
Noy, S., & Ray, R. (2012). Graduate students' perceptions of their advisors: Is there systematic disadvantage in mentorship? *The Journal of Higher Education, 83*(6), 876–914.
O'Meara, K., Knudsen, K., & Jones, J. (2013). The role of emotional competencies in faculty-doctoral student relationships. *The Review of Higher Education, 36*(3), 315–347.
Patton, L. D. (2009). My sister's keeper: A qualitative examination of mentoring experiences among African American women in graduate and professional schools. *The Journal of Higher Education, 80*(5), 510–537.
Young, A.M, & Perrewé, P.L. (2004). The role of expectations in the mentoring exchange: An analysis of mentor and protégé expectations in relation to perceived support. *Journal of Managerial Issues, 16*(1), 103-126.
Ponterotto, J. G. (2005). Qualitative research in counseling psychology: A primer on research paradigms and philosophy of science. *Journal of Counseling Psychology, 52*(2), 126–136.
Roksa, J., Feldon, D. F., & Maher, M. (2018). First-generation students in pursuit of the Ph.D.: Comparing socialization experiences and outcomes to continuing-generation peers. *The Journal of Higher Education, 89*(5), 728–752.
Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Sage.
Sallee, M. W. (2011). Toward a theory of gendered socialization. *NASPA Journal about Women in Higher Education, 4*(2), 170–192.
Schlosser, L. Z., Knox, S., Moskovitz, A. R., & Hill, C. E. (2003). A qualitative examination of graduate advising relationships: The advisee perspective. *Journal of Counseling Psychology, 50*(2), 178–188.
Stuber, J. M. (2011). *Inside the college gates: How class and culture matter in higher education*. Lexington Books.
Sweitzer, V. (2009). Towards a theory of doctoral student professional identity development: A developmental networks approach. *Journal of Higher Education, 80*(1), 1–33.
Twale, D. J., Weidman, J. C., & Bethea, K. (2016). Conceptualizing socialization of graduate students of color: Revisiting the Weidman-Twale-Stein framework. *Western Journal of Black Studies, 40*(2), 80–94.
Valantine, H. A., & Collins, F. S. (2015). National Institutes of Health addresses the science of diversity. *Proceedings of the National Academy of Sciences, 112*(40), 12240–12242.
Weidman, J. C., & DeAngelo, L. (Eds.). (2020). *Socialization in higher education and the early career: Theory, research and application* (Vol. 7). Springer International Publishing.

Weidman, J. C., Twale, D. J., & Stein, E. L. (2001). Socialization of graduate and professional students in higher education: A perilous passage? *ASHE-ERIC Higher Education Report, 28*(3), 1–136.

Wofford, A. M., & Blaney, J. M. (2021). (Re)Shaping the socialization of scientific labs: Understanding women's doctoral experiences in STEM lab rotations. *The Review of Higher Education, 44*(3), 357–386.