

Examining How Student Identities Interact with an Immersive Field Ecology Course and its Implications for Graduate School Education

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ABSTRACT

One of the central issues in ecology is the underrepresentation of individuals from diverse backgrounds. This underrepresentation starts at the undergraduate level and continues into graduate programs, contributing to a need for more diversity in the discipline. We hypothesize that the interplay of students' identities and contextual factors influence how students perceive their sense of belonging in a field-based discipline. We present findings from a 2-yr evaluation of a pregraduate school field program, FIRED UP (Field-Intensive Research Emphasizing Diversity UP in the alpine), where students interacted with a curriculum focused on building field skills and cohort bonding. Students provided feedback through surveys and interviews conducted at various phases throughout the program. Using the Phenomenological Variant Ecological Systems Theory, we present our interview results in three cases describing differing student outcomes regarding belonging which allows us to give voice and weight to students with more critical and constructive perspectives. Thus, the results of this study can be used to critically examine field-based educational program design to maximize the ability of programs to respond to diverse student needs. The broader implications of this work address how to approach pregraduate school training and cohort building that supports students marginalized in science, technology, engineering and mathematics (STEM) disciplines as they enter graduate school.

INTRODUCTION: LEVERAGING INTENTIONALLY DESIGNED FIELD EXPERIENCES FOR COMMUNITY BUILDING IN EBIO GRADUATE STUDENTS

The under-representation of individuals from diverse backgrounds is a central issue in ecology and evolutionary biology (EEB) (Race *et al.*, 2021). This underrepresentation starts at the undergraduate level and continues into graduate programs, contributing to a need for more diversity in the professional workforce (Morales and Reano, 2023). The benefits of diversifying the STEM workforce include significant scientific impact for diverse collaborations and broadening scientific inquiry to include topics relevant to a more substantial portion of society (Campbell *et al.*, 2013; Nielsen *et al.*, 2017). A diverse EEB workforce is also needed because global environmental problems require the application of EEB solutions and diverse community engagement. The 2023 NSF report on diversity and STEM indicates that natural sciences remain the least diverse among all STEM fields (National Center for Science and Engineering Statistics NCSES, 2023). To address this issue, increasing access for students marginalized in STEM by systemic and institutional barriers must be a social justice effort (Campbell *et al.*, 2000; Grogan, 2019). By marginalized we mean students who are members of groups that have been treated as less significant, peripheral, or who have been isolated or

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disempowered in STEM contexts (Bhatti, 2021). This term is broad and not specific, reflecting the reality that there are many different groups that are described by this term and that the STEM context enacts the marginalization. Given this, our work relies on students' descriptions of their own identities and experiences and does not extrapolate individual experiences to any specific demographic group. It is the shared characteristic of holding an identity marginalized in STEM that sets the bounds of this term.

There has been an increased effort within the education research community to understand effective ways to improve the science workforce capacity within frameworks that enable equity, inclusion, access, and social justice (e.g., Vetter et al., 2022). Keeping in line with this effort, various research studies seek to understand ways to improve access for students marginalized in STEM disciplines (Levine et al., 2007; Lent et al., 2008). These studies identify that most graduate programs in the United States fail to attend to the priorities aligned with students' cultures and values leading to low retention of students marginalized in STEM fields (Puritty et al., 2017). Discrimination, microaggressions, structural and systemic biases have been recognized as factors contributing to this low retention of students marginalized in STEM fields. Low retention, in turn, leads to lack of role models or mentors from similar backgrounds and can result in a lack of sense of community which is crucial for success in graduate programs. Thus, graduate students marginalized in STEM are disproportionately impacted by issues of retention (Miller et al., 2021; Morales and Reano, 2023). It is the responsibility of STEM graduate educational programs to introduce changes that can lead to more inclusion and foster a sense of belonging for individuals from marginalized backgrounds. Research practices in outdoor environments (fieldwork) are one avenue that offers an opportunity to introduce graduate students to STEM disciplines and departments through the lens of their own values to foster a greater sense of community and belonging within their fields.

In disciplines such as EEB, the practice of fieldwork is perceived to be an integrated element of a field scientist's identity. Fieldwork can be linked to the process of scientific knowledge production and is an integral part of the process of being a scientist that enables students to become disciplinary experts as they progress along the novice to expert continuum (Petcovic and Libarkin, 2007). Fieldwork can enable proficiency in field techniques while connecting students to relevant issues of global ecological interest through a place-based and experiential approach (Race et al., 2021; Morales and Reano, 2023). Fieldwork experiences also foster development of skills such as interpersonal communication, critical thinking, and collaboration that inspire big-picture science thinking essential for mitigating global environmental challenges (Wyborn et al., 2021).

However, fieldwork experiences can result in negative associations with the discipline, leading to student dropouts (Giles et al., 2020). Studies exploring undergraduate student experiences from field-specific disciplines suggest that students marginalized in STEM disciplines (such as women, racial ethnic minorities, students with disabilities, and members of the LGBTQ+ community) tend to face more structural barriers and microaggressions than their majority peers throughout

the duration of their program (Pfeifer et al., 2020; Morales and Reano, 2023; Rowan, 2023). For example, students of underrepresented racial groups often feel that they do not belong in the field because of an absence of others who share their identities in the workplace, leading to lack of community and sense of belonging (Leaper and Starr, 2019). Additionally, fieldwork often requires travel in rural locations with polarized political populations that may pose more personal safety risks for students marginalized in STEM disciplines (Kamran and Jennings, 2023; Toone et al., 2023). Fieldwork in physically challenging environments may pose significant barriers to participation for certain students leading to negative perceptions of field disciplines (Stokes et al., 2019). Exposure to research experiences, learning how to use material resources, and finding relatable mentors can strongly impact students' science identities and are frequently not accessible for students from marginalized groups. This can especially be challenging in field environments (Haeger and Fresquez, 2016), and represents a significant missed opportunity for STEM fields to increase retention since factors such as *student self-efficacy*, *motivation*, and *authentic learning experiences* (Graham et al., 2013) can be fostered in a field environment (Gilmore et al., 2011; Robnett et al., 2018). To promote a sense of belonging which is a crucial element of retention in STEM majors, we need to understand what components of fieldwork lead to positive student outcomes for students from diverse backgrounds and who hold diverse identities.

Several studies indicate that positive affective experiences can be instrumental in fostering successful fieldwork experiences and increasing sense of belonging in the field (LaDue and Pacheco, 2013; van der Hoeven Kraft et al., 2011). In the education literature, affect is defined as attitudes, emotions, and values present in an educational environment. Student affect during fieldwork is shaped by the complex interactions between students' identities and the contextual factors of the field (social interactions, physical location, etc.). Students' individual identities emerge from complex amalgamations of identity dimensions such as gender, race, socioeconomic status, and contextual influences such as family background and life experiences (Jones and McEwen, 2000). Such influences determine how students navigate their identities in the field (Malm et al., 2020). Understanding how fieldwork experiences interact with student identities and impact student experiences can be useful in informing the structure of more inclusive programs but remains lacking at the graduate level. Studies on student retention identify graduate schools as a critical stage where students tend to leave the academic pipeline and pursue other career paths (LaDue and Pacheco, 2013). As such, intentionally designed graduate programs that cultivate cohort bonding in addition to relevant fieldwork training and inspire big-picture science thinking have potential to increase student self-efficacy, belonging, and persistence.

We hypothesize that the interplay of students' identities (such as gender, physical ability, international status) and contextual factors (such as components of a specific program and location) influence individual experiences and how students perceive their sense of belonging in field-based disciplines. Here, we evaluate the components of an immersive field-based pregraduate program, FIRED UP (Field-Intensive

Research Emphasizing Diversity UP in the alpine), in the Department of Ecology and Evolutionary Biology at the University of Colorado Boulder. More specifically, we explore how FIRED UP interacts with student identities and affects community building for incoming graduate students. By exploring the role of community building and sense of belonging in graduate school, findings from this study can inform the development of effective field-based programs and interventions that support student needs, encourage cohort-bonding, and promote diversity, equity, and inclusion in STEM fields at the graduate level. We emphasize components of fieldwork for community building as it is transformative for student learning and sense of belonging.

Study Objectives and Theoretical Approach

To understand how field experiences foster community building and instill a sense of belonging, it is important to identify the parameters that contribute toward positive field experiences (van der Hoeven Kraft *et al.*, 2011). Field experiences not only offer opportunities to learn discipline-specific skills and knowledge but can also build an individual's self-efficacy and self-image and develop professional and social networks (Jolley *et al.*, 2018; Halliwell *et al.*, 2022). Positive fieldwork experiences also influence students' intention to persist (Kortz *et al.*, 2020; Núñez *et al.*, 2021).

A growing body of research from other natural science disciplines with components of fieldwork (such as geology) indicates that students' persistence is influenced by complex interactions between various psychosocial, academic, and environmental factors (van der Hoeven Kraft *et al.*, 2011; LaDue and Pacheco, 2013). Furthermore, students' academic achievements can be linked to various affective and situational factors during fieldwork such as students' attitudes, emotions, ideas of self-efficacy, mentors, role models, knowledge of careers, and family (LaDue and Pacheco, 2013; van der Hoeven Kraft *et al.*, 2011; Treibergs *et al.*, 2022). In this study, the outcome of interest is students' sense of belonging to their cohort and the broader EEB community, which can be predictive of students' persistence (Pedler *et al.*, 2022).

To examine the interplay of the program with students' identities and the subsequent influence on outcomes, we ask the following research questions and discuss the theoretical underpinning of this work next:

1. What were the identities students discussed that influenced their goals and expectations from the field program?
2. What were students' lived experiences of how their identities influenced their sense of belonging and community building during FIRED UP?

Merging Self-determination Theory with the Phenomenological Variant of Ecological Systems Theory Framework to Study How Students Navigate Fieldwork and its Implications for Persistence in Graduate School. Contextual influences such as life experiences and dimensions of identity factor into how students make sense of a collective experience and build relatedness. According to the self-determination theory (SDT), when students are in control of their learning experience (autonomy), feel confident in completing tasks (efficacy), and experience belonging within a learning com-

munity (relatedness), they are more likely to be motivated to engage (Deci and Ryan, 2012; van der Hoeven Kraft *et al.*, 2011). Students who are supported in autonomy, efficacy and relatedness develop resilience, or the ability to successfully navigate unforeseen obstacles in their discipline and are more likely to persist (Race *et al.*, 2021). Other studies and theoretical work in field education such as van der Hoeven Kraft *et al.* (2011) and LaDue and Pacheco (2013) build on SDT to suggest how belonging in field contexts relates positively to relatedness. Studies on field education also recognize the positive relation between relatedness and scientific literacy as well as future science plans (Shaulskiy *et al.*, 2022). Here, we adopt Spencer's (1997) phenomenological variant of ecological systems theory (PVEST) framework to investigate how students' identities interact with the context of a pregraduate school field experience to influence belonging and community building, which in turn influence relatedness. This framework explores the intersection of various dimensions of identity (such as race, self-recognized physical abilities, cultural backgrounds, and demographics) in a sociocultural learning context such as fieldwork, and it describes how a sense of belonging and identity can form. The PVEST framework provides insight into how interpersonal interactions may be experienced by an individual and contributes toward the development of their overall science identity and willingness to engage in a particular program or broader discipline.

PVEST highlights an engagement cycle consisting of 1) risk contributors, 2) stress engagements, 3) reactive coping methods, 4) stable coping responses, and 5) life stage outcomes (Figure 1). In this work, we refrain from using the term risk contributors as identified in the PVEST framework (Spencer *et al.*, 1997) and instead refer to students' *incoming identities* to avoid framing identity aspects as risks. We also do not comment extensively on life stage outcomes as our data do not extend far enough to describe this step. According to PVEST, incoming identities interact with an environment to give rise to positive or negative stress engagements. In a typical PVEST approach, stress components might include factors such as neighborhood dangers, opportunities for social support, or daily hassles. For our study, we characterize components of the FIRED UP program as external stress engagements which can be both positive and negative and influence how students navigate the fieldwork experience (reactive coping methods). These factors eventually influence students' stable coping responses (i.e., how one consistently responds to stressors), emergent identities, and affective outcomes (Figure 1). Below we use prior work to illustrate how PVEST might be leveraged to track and investigate field experiences and resulting outcomes.

While prior work acknowledges many positive outcomes of field experiences (reviewed in van der Hoeven Kraft *et al.*, 2011), a vast majority of this work also acknowledges that these experiences can act as *stress engagements* (Stokes *et al.*, 2019; Malm *et al.*, 2020; Núñez *et al.*, 2021; Cisneros and Guhlincozzi, 2023). These stress engagements are different depending on students' identities (Coon *et al.*, 2023), and abilities (Stokes *et al.*, 2019; Mendelson III, 2022). For example, holding a transgender identity may be stressful when that student is not

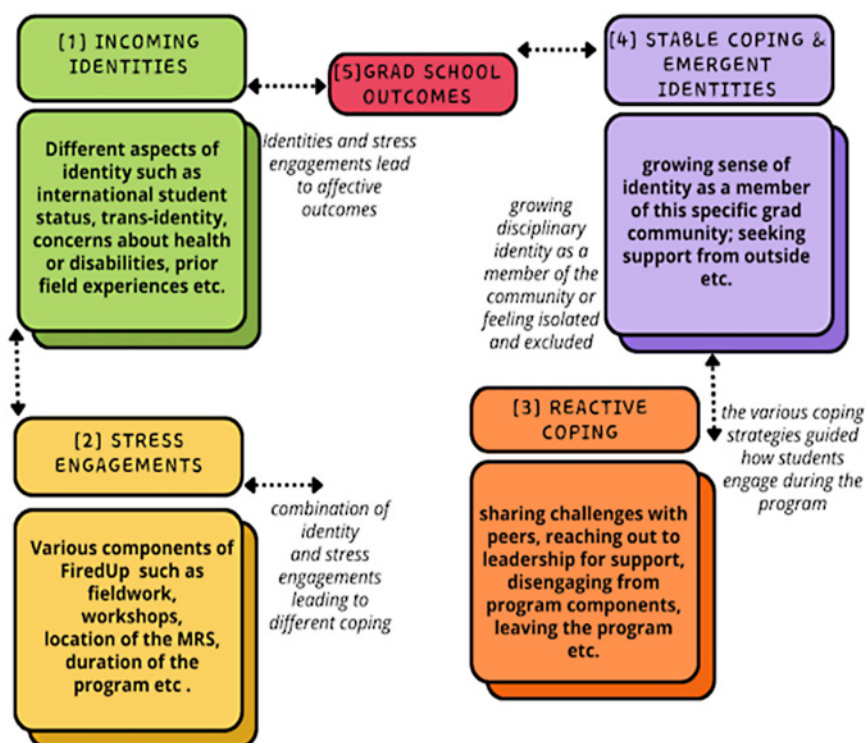


FIGURE 1. Spencer's (1997) PVEST framework modified for the context of FIRED UP. The various factors in this framework are 1) incoming identities, 2) stress engagements, 3) reactive coping, and 4) stable coping and emergent identities may impact 5) grad school outcomes. In this work, we discuss factors 1) through 4). Each of these factors are described below the numbered factors (in bold) and the contexts for each of these are labeled (in italics). The various themes that form the basis of the analysis in this study emerged from the coding process described in Figure 2. Then, using PVEST as our guiding framework, we went back into the data to characterize incoming identities, stress engagements, reactive coping, stable coping, and emerging identities, being mindful of themes within each of these PVEST stages that emerged within each case. Our emergent codes helped us determine each of the above because our codes often described each stage, thus PVEST was an important part of our thematic analysis. We refrained from using PVEST as a coding framework, to allow the various themes to emerge independently from the student interviews.

out to their fieldwork colleagues, or when they enter a socio-political space that does not welcome their identity which happens frequently in rural field settings (Kottler et al., 2023). This is an example of how stress engagements arise from entering identities interacting with contextual factors within a system. In many prior studies, there are either explicit (John and Khan, 2018) or implied *reactive coping responses* which describe what students do in response to stress engagements (Chiarella and Vurro, 2020). Because of stress and as part of students' *reactive coping responses*, students might leave the field experience or if they choose to stay, they may choose to not reveal hidden identities (Kamran and Jennings, 2023), or they may take other actions that allow them to cope with the immediate situation. One can imagine that the transgender student mentioned above may choose to either disclose their identity or work to obscure it, and that this decision may have an impact on their experience, safety, and potential for building community. Treibergs and colleagues (2023) describe how ultimately these actions lead to *stable coping responses* that can either have positive implications for disciplines incorporating field science (e.g., students consistently re-engaging in field science) or have negative consequences for field science (e.g., students depart from and consistently avoid field science). Notably, when someone develops a stable coping

response because of engagement, it can be either positive or negative for them personally regardless of whether they stay or leave. Leaving a field may support overall well-being for a student but represents the loss of that individual's potential for the field. *Stable coping responses* lead to stable identities and *life stage outcomes*, such as being confident about field skills, etc. (O'Connell et al., 2022) and identifying as a field scientist (or not). In this study we don't comment on life stage outcomes (or grad school outcomes) as that would require a longer longitudinal component of research.

Studies on affective outcomes of field education such as science identity, science self-efficacy and motivation to persist have cited students' place attachment or connections to aesthetics as influencing these positive outcomes (Semken et al., 2017; Jolley et al., 2018; Peasland et al., 2021; Race et al., 2021). However, students may also find field experiences to be frustrating (Baum et al., 2012), anxiety-inducing (Cotton, 2009), or even boring (Stokes and Boyle, 2009). This demonstrates a spectrum of emotional responses that students can have when engaging within the field that may contribute to their stress engagements and reactive coping. Notably, this prior work was conducted mostly in the context of undergraduate education, where students may have other opportunities to find a sense of community such as taking

classes together, etc. In the graduate education context, opportunities for finding community might be limited as most students take classes depending on their specific interests and may not engage in other outside shared experiences.

If a field course is to be leveraged to promote a sense of belonging, science identity and motivation to persist in the discipline for graduate students, what do we need to consider? To answer this question, we must closely examine experiences from diverse groups of students. We must characterize and understand the nuance of how context, social connections, and identity interact with experiences in the field so that program design can be adjusted to best meet student needs. Here, we draw upon a 2-year study of a novel graduate program model, FIRED UP in the Department of Ecology and Evolutionary Biology at the University of Colorado Boulder, to investigate how student identities interact with program components to influence belonging and community formation prior to the start of graduate school.

MATERIALS AND METHODS

This research was conducted with approval from the University of Colorado, Boulder institutional review board IRB # 21-0086 (Institutional Review Board).

Positionality Statement

We are a group of discipline-based education researchers, ecologists, evolutionary biologists, and geologists. Our identities include those of early-career and mid-career ecology, evolutionary biology, and education researchers. Many of us hold identities that have been historically underserved in STEM fields or frequently pose additional challenges for individuals seeking to belong in STEM. Members of our PI group identify as children of immigrants, military families, and rural communities. One of us identifies as Hispanic, and one of us is openly gay. These identities not only inform our positionality—the lens through which we view the world—but also our priorities and values.

Authors V.M., N.E., J.R., and S.T. were involved in producing and enacting the curriculum that underlies this work and contributing insights from their lived experience during data analysis. Authors L.C., S.K., and S.S. have backgrounds in education research, field education (geology and EEB), etc. and led the program evaluation and research such as distribution of the surveys, conducting interviews with students and analyzing the data. To fully understand the socio-cultural contexts of the program and how various aspects of the program interacted with student experiences, authors S.S. and S.K. also participated in FIRED UP, that is, spent time at the Mountain Research Station (MRS) during the program. Separating the roles of the curriculum development and implementation team from the research team helped us to avoid potential conflict of interests, cohesion of participants and provided rich insights into interpersonal and social dynamics during the program.

Program Description: FIRED UP

Students in EEB disciplines often enter directly into a mentor's lab and do not participate early-on in experiences that would allow them to explore their relationships with other faculty

or develop interdisciplinary skills. While some graduate programs have components that facilitate cohort bonding (Moslemi *et al.*, 2009), it is rare for this to be an explicit focus of graduate students' first several months in a program (Venkatesh *et al.*, 2021). However, we know from prior studies on students' graduate education in STEM fields that social components of graduate study are critically important for community formation and sense of belonging and contribute to outcomes such as well-being, preparation for academic positions, successful navigation of graduate school, and formation of a support network (Trujillo and Tanner, 2014; Moreira *et al.*, 2019). Building on this prior work, we hypothesize that a cohort-building experience during the summer prior to the first year in graduate school can enable students to foster a sense of community, instill confidence, and provide them an analytical toolkit they need to succeed in graduate school.

FIRED UP is designed as a training program for incoming graduate students targeting the summer prior to the start of graduate school and has two specific goals around field training and community building. In this study, we focus on the aspect of community building in graduate school. During the program, students live together at the University of Colorado MRS in the Colorado Front Range of the Rocky Mountains. The MRS is a site of long-term ecological research projects (e.g., Niwot Ridge LTER) on fundamental concepts involving the diversity, productivity, and resilience of alpine biological communities under a changing climate (Suding *et al.*, 2015).

In preparation for each year's field course, the project leaders provided significant outreach and communication to students to allow them to make an informed choice of whether to participate in FIRED UP. All admitted master's and PhD graduate students were offered a spot to attend the program (18 students each in years 1 and 2). In winter, during recruitment and admission to the graduate degree program, students were first introduced to FIRED UP via email and through the FIRED UP website. In early spring, project leaders held remote video calls to provide information about the program and answer questions. All students were offered financial incentive packages to offset the cost of personal field gear needed to attend the program (e.g., raincoat, hiking shoes), assistance with moving costs, rent, etc. FIRED UP provided lodging, meals, journals, art supplies, and snacks. The intent was for the program to be zero cost for student participants.

The project leaders provided a complete packing list of items needed and collected survey information about food allergies, food preferences, need for disability accommodations, relevant health conditions, emergency contact information, as well as any concerns students wanted to discuss. Students were also invited to fill out a preprogram questionnaire, to express any specific concerns or needs for their success in the program. One question that was asked was, "Do you want to let us know about any concerns that you have or anything that may limit your ability to participate in FIRED UP?" Considering some of the logistical challenges that came up in Y1, a second question that was asked in Y2 was "Will you be requesting any Americans with Disabilities Act accommodations during your stay at the MRS? Please explain your needs." These questions allowed students to disclose whatever they felt was relevant for their success in the program. In response to this question, students described

physical and mental health challenges that the participants describe or disclose as abilities or disabilities.

All students were offered transportation from Boulder to the MRS, and some students chose to use personal vehicles. The schedule of activities was shared with all students and project leaders communicated that students could choose not to participate in any activity, and that for any field activities that required hiking, students would have multiple options corresponding to different exertion levels. Daily activities included field/science activities in the morning and group connection activities in the afternoons and evenings. In Y1 (a 4-wk program), all 18 students chose to attend FIRED UP (though 7 were not able to attend the full 4 wk due to other commitments). In Y2 (a 2-wk program), 17 of the 18 admitted students chose to attend, again with a few students arriving later due to prior commitments.

In Y1, FIRED UP was conducted over 4 wk at the MRS with targeted activities for each week including fieldwork, workshops, scientific presentations and built-in free time for the students. These activities are listed in the Supplement (Item 1). The primary focus for week 1 was on introductions, gear preparations and safety training around the MRS. In weeks 2 through 4, the focus shifted toward different field methodologies and skills such as science communications, reading scientific papers, and field sampling methodologies designed within various subject specific themes. In addition to providing students exposure to different research methodologies through structured hands-on workshops, daily group discussions (or “ring of fire” meetings) were aimed to provide familiarity with different topics of relevance for graduate school such as imposter syndrome, Diversity, Equity, and Inclusion discussions, and discussions around building one’s own scientist narrative. Through facilitated discussion of these topics, the program leaders aimed to provide opportunities for community building and development of belonging within the cohort. This included explicit messaging to students communicating appreciation for their presence as an important part of the graduate program. The various field activities emphasized elements known to increase confidence and effective group dynamics, such as exercises focused on team building, the creation of safe spaces, formal and informal mentoring, and the development of self-efficacy and science identity (Ballen *et al.*, 2017). There were also informal social gatherings where current continuing graduate students were invited to interact with the FIRED UP students (incoming graduate students). Occasionally EBIO faculty members who were not part of the FIRED UP leadership team attended field outings and participated in the program (~3 times for each offering).

In Y1, 7 students in the incoming cohort indicated prior commitments and could participate only in the last week of the program, leading to differences in student experiences and physical exhaustion (explained in the Results section). As such, in Y2, FIRED UP was planned over 2 wk to provide students with an opportunity to get acquainted with their cohort, get some understanding of different methodologies and field techniques and prevent instances of exhaustion as mentioned by Y1 students. The various components of the program in Y2 are listed in the Supplement (Item 2). During the program, we invited the students to provide feedback

on the program through surveys and interviews as discussed below.

Survey and Interview Protocol Development

Both survey data and interview data were collected from the students in the cohort. We only present the interview data in this work as this is more relevant for the discussion around identities, which is the central theme for this paper. The surveys are described as they may have influenced students’ responses to interviews.

The pre and post surveys were developed to measure students’ competencies and self-efficacies entering the program and leaving the program (FIRED UP). We also collected demographic data through departmental program records as allowed by our IRB protocol. The survey included measures of research self-efficacy (Chemers *et al.*, 2011), statistics self-efficacy (Finney and Schraw, 2003), coping self-efficacy (Chesney *et al.*, 2006), and science identity (Estrada *et al.*, 2011), aspects of competence and relatedness that the team was interested in examining. While the data from the survey are not presented in this paper, it sets the framing for the preinterviews and helped to communicate to students the priorities of the FIRED UP team regarding evaluation and program improvement. The survey gave us an understanding of our students’ prior experiences which helped inform the codebook development and helped us to contextualize the interview responses.

Interview protocols were developed using SDT as a guiding framework. Interview questions were codeveloped by authors S.K., S.S., and L.C. and iteratively revised by the entire author team. After this revision, questions were presented to an external advisory board consisting of education research and scientific field research experts and program evaluators. A final round of revision occurred after feedback was received from the advisory committee.

The interview protocols include questions that ask students about their sense of developing competence, relatedness, and autonomy. In the pre-FIRED UP interviews, we asked students to share their prior experiences with research and how they became interested in FIRED UP and more broadly in the graduate program. The mid-FIRED UP interviews focused on affective aspects of FIRED UP and relatedness and competence. The post-FIRED UP interviews asked students to report on the most salient aspects of their experience in addition to how FIRED UP had impacted their relationship with departmental faculty, students, and the graduate program. The post interviews also solicited suggestions for program improvement (Item 3, Supplement, Interview Questions).

Evaluation and Informed Design

To evaluate the efficacy of the program and conduct this research, we invited the participating students to provide feedback at various stages via the surveys and interviews described above. Students were first invited to fill out an online consent form. Students who consented to participate were invited to fill out the presurvey, which took ~20 min to complete. Students who indicated further interest in the evaluation were invited to participate in a pre-FIRED UP interview ($n = 23$ participants out of 35 total invited). These interviews lasted

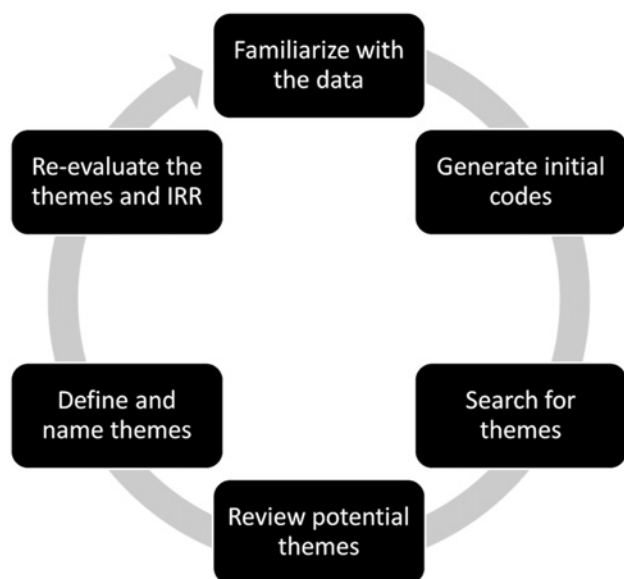


FIGURE 2. Schematic depicting the iterative process of codebook development. The transcripts were read several times to identify emergent themes. With further reading, subcodes were added. Once the codes were agreed upon, interviews were coded by individual coders to establish reliability.

for 30 to 45 min and were completed by the first day of the program prior to when students departed for the MRS.

Halfway through the program, we invited all students to participate in a mid-FIRED UP interview. Those students who expressed interest in participating in the evaluations were invited for a 30- to 45-min interview ($n = 24$). Interviews were completed by the start of wk 3 in Y1 and wk 1 in Y2 on-site at the MRS during scheduled breaks between activities. After the program ended, all students were invited to fill out a post-FIRED UP survey as part of the reflective processes for the program. Students who indicated interest in participating in a post-FIRED UP interview on the final survey were invited for a final interview ($n = 28$). All post-FIRED UP interviews were completed between 2 and 3 wk after the program ended on the campus or via zoom where the students were beginning their graduate program. As an incentive for participating, all students received amazon gift cards (\$10 for each survey and \$20 for each interview).

Analysis and Codebook Development

Authors S.S. and L.C. transcribed the interviews using transcription software (otter.com and rev.com). S.S. and L.C. then analyzed the transcripts using an inductive approach. We read the transcripts iteratively to identify themes that influenced students' experiences during the program. We continued to re-categorize the emergent themes until consensus was reached and the codes captured the various nuances of a particular theme (Figure 2). Once the codes were identified, we continued discussions to identify subcodes until consensus was reached.

This was followed by an interrater reliability process (IRR) which refers to the degree of agreement between individual coders. For this process, S.S. first read all the interviews and

coded them independently and L.C. read six interviews and coded them independently. After an initial comparison of these codes, S.S. chose 80% of quotes from interviews L.C. had not read to copy into a separate document. L.C. coded these independently to calculate IRR. For Y1, for the pre-FIRED UP interviews, from a sample of 88 quotes, 80 quotes were coded under the same category (90% match); four quotes were cross-referenced with additional codes (i.e., these quotes appeared for multiple codes) and four quotes were entirely different. We reached a consensus for these eight quotes after discussion. Similarly, for the mid-FIRED UP interviews, out of 50 quotes, 28 quotes were exact matches, 18 quotes matched and were coreferenced with other codes, four codes did not match. All these differences were reconciled through discussions. The IRR was repeated for each set of interviews: that is, mid-FIRED UP (90% match); post-FIRED UP (83.3% match).

For Y2, we followed a similar process using the codebook developed in Y1 and cocoded six interviews from Y2. Given the high IRR agreement from Y1 data, S.S. coded all the interviews for Y2 and discussed any questions about codes with L.C. when needed. After the analysis was complete, we also used member checking for the use of student quotes described (which we describe in the Results section). We analyzed all codes to understand how students felt about belonging within their cohort and to the broader EBIO community. From this process, we identified three cases grounded in students' sense of belonging. Specifically, these cases arose from the emergent codes we had identified iteratively in the coding process. Using these emergent codes, we examined the data and evaluated each student's experience to determine whether they fit within the cases we had characterized. We found all the students' experiences fit within the three emergent themes (i.e., cases). Then, using PVEST as our guiding framework, we went back into the data to characterize incoming identities, stress engagements, reactive coping, stable coping, and emerging identities, being mindful of themes within each of these PVEST stages that emerged within each case.

A brief overview of the codebook is first presented in the next section. The main codes are represented in bold and the subcodes are italicized. The cases summarizing students' sense of belonging are then described and discussed in the context of the PVEST framework. The complete codebook is included in the Supplement (Item 4 Supplement).

Codes Emergent from the Pre-FIRED UP Interviews. In the pre-FIRED UP interviews, we asked students what factors shaped their interests in EBIO to understand their expectations for participation in FIRED UP (Item 3, Supplement). We found 11 codes that influenced student interest in the discipline and describe these below. These codes are presented in bold and provide insight into students' prior experiences that guide their motivation and expectations for the program.

When students discussed that their interest was driven by various aspects of nature such as mountains, wildlife or environment, we coded it under **connections to Earth**. Discussions around emotions, attitudes, motivation and values were coded under **affective aspects**. Participants' aspirations around environmental advocacy, interest in a specific career, or a specific disciplinary pursuit were coded under **career goals**. Further discussion revealed that these career goals

were framed by their prior experiences in the discipline. Ideas around factors that shaped their perceptions around their roles and membership in science were coded under **identity** along with any expression of affiliation with different groups, demographics, or categories that students mentioned. Discussions around challenges or limitations that the students might encounter during FIRED UP were coded under **constraints**. Prior experiences in the discipline that motivated them to learn more about the subject area were coded under **interest**. Connections to mountains, landscape and geography were coded under **place**. Sometimes place and connections to Earth were cross-referenced depending on the context. Likewise, interest and career goals could be cross referenced when prior experiences were described that led to a specific career goal. Interest about working at the interface of multiple subdisciplines to develop understanding of different methodologies was coded under **interdisciplinarity**. Skills that students expected to develop during FIRED UP and how these might enable them to execute behaviors necessary to produce specific performance outcomes were coded under **self-efficacy (SE)**. Interests in finding community in graduate school when asked about expectations for the program were coded under **relatability and community**.

To further capture the nuances of these broad codes, we added subcodes where relevant. These are italicized to distinguish them from the main codes. For example, career goals has two subcodes: *academia* and *environmental justice*; constraints has three subcodes: *financial constraints*, *isolation*, and *physical challenges*; identity has two subcodes: *social* and *science identity*; and interest has two subcodes: *developing individual interest* and *triggered sustained interest*. Readers are encouraged to refer to the Supplemental file (Item 4) for further details for the codes with specific examples.

Codes Emergent from the Mid-FIRED UP Interviews. The mid-FIRED UP interviews were conducted halfway through the program, that is, after 2 wk for Y1 and after 1 wk for Y2. Students were asked about their experiences during the program, what aspects they were enjoying and what challenges they encountered (Item 3, Supplement). Themes from mid-FIRED UP interviews inform our understanding of how students' incoming identities interact with some of the program components and impact initial student experiences. Themes emerging from the mid-FIRED UP interviews were categorized into the following three main codes represented in bold (subcodes are italicized).

- 1) **Transformative challenges** describe students' discussions of how challenges pertaining to the program enabled them to feel connected or disconnected. Challenges are defined as stimulating tasks or problems that often present different levels of difficulty for students. These challenges were further subdivided into *program challenges* (accessibility, remote location, difficulty of skill development), *health issues*, concerns around navigating graduate school (*imposter syndrome*) and sharing aspects of their personalities that students were less confident about (*vulnerabilities*).
- 2) **Core values** were principles or beliefs that determined how participants interacted during the program. These

codes were further categorized depending on what aspects influenced the interactions. For example, some students with prior field experience approached the program with an idea of supporting their peers (*accepting*), for some students being able to express their identity or personality was an important aspect of how they felt about their community (*affective*). Sometimes connections between peers occurred over attachments to mountains or the ecology of the place (*aesthetics*).

- 3) **Skills** describe different skills students were building and aspects of efficacy that students felt throughout the program such as skills in *communication*, *interdisciplinarity*, *reflection*, *science skills*, *social skills*, and *critical thinking*.

Codes Emergent from the Post-FIRED UP Interviews. In the post-FIRED UP interviews, we asked students about their experiences in the field-program, and how different aspects of the program such as fieldwork, social components, etc. influenced their sense of belonging, connections to other students, faculty, and other researchers and overall skills that students gained during the experience (Item 3, Supplement). Themes from the post-FIRED UP interviews were categorized into two main codes (in bold) with various sub-codes (italicized) as described below.

- 1) **Program components** that *supported belonging*; that were *flexible*, that *challenged belonging*, and that *fostered a sense of community*. Aspects of the program that supported belonging were coded under *relatability* (i.e., connections that participants felt with various experts/scientists); *approachability* (i.e., ease of discussing their concerns with various mentors/experts); *flexibility* (i.e., structure of FIRED UP that had a balance of structured activities such as field work, talks etc., and unstructured free time and also options for how to participate). Some aspects of the program challenged belonging such as *accessibility and isolation* (referring to constraints around remote location of the MRS), *burn-out* (when students describe feelings of being drained or exhausted), *discomfort* (concerns participants expressed about peer pressure to participate in various activities), *food* (concerns participants expressed about the food at the MRS and nutrition), *inclusivity* (Issues around feeling excluded or feeling left out—either due to abilities, personalities, or locations of the cabins). Aspects of the program that fostered a sense of community were *modeling mentorship* (affinity shown by the program leaders to exhibit care and value to the participants of FIRED UP); *formal mentorship* (support provided by a students' designated faculty mentor that aligns with the support expected by the graduate program, e.g., help with dissertation design, data collection, writing, attending conferences, presenting, etc.), *informal mentorship* (support provided by various faculty to the participants in the form of advice or handling logistics around academics and addressing their concerns).
- 2) **Skills** gained during the field experience such as *accountability* (being accountable to one's professional goals), *being a scientist* (critical thinking, problem

solving, and developing a successful approach to research), *building relationships* (building healthy, productive relationships with peers), *efficacy around structured activities* (development of self-efficacy in skills due to FIRED UP activities), *disciplinary skills* (building skills relevant for EEB), *networking* (building relationships with peers that are specific to professional aspects of interaction) and *time management* (managing one's time so as to accomplish professional goals and maintain well-being).

Detailed descriptions of each code and specific examples from the transcripts are included in the codebook (Item 4, Supplement). The above codes capture student thinking at three timepoints of the FIRED UP experience and beyond. The results below synthesize the understandings that emerge from viewing these across the whole experience.

RESULTS: FACTORS SHAPING STUDENTS' EXPERIENCES DURING FIRED UP

We previously described how Spencer's PVEST model can allow us to examine the interaction of different contextual factors (particularly the components of FIRED UP) with students' reported identities and how FIRED UP impacts student experiences during fieldwork. In the following sections, we draw upon the pre-FIRED UP, mid-FIRED UP and post-FIRED UP interviews and discuss these in the context of the PVEST framework. The first section (1) explores the salience of identities in the context of student experience in FIRED UP, while the second section (2) focuses on presenting the emerging identities as three cases using PVEST. Analyzing the student interviews enabled us to identify three cases across the FIRED UP cohorts where students develop different levels of sense of belonging and different valences of connection within their cohort. While we did not use a case study approach to investigate this work, the emergent trajectories of student experience were best captured as "cases." These cases represent experiences shared by multiple participants and we present quotes from different students as evidence in support of each case. Presenting the results in this way enables us to fully explore the research questions since, for each case, students' identities interact with the program components in specific ways to elicit different outcomes regarding belonging.

In presenting our results, we do not use student pseudonyms or connect student quotes to anonymous student identifiers as this group is small. We also use pronouns they/them when referring to student quotes. We are concerned that connecting quotes to one another via a pseudonym or gender identities might provide ways for individuals familiar with this program to indirectly identify research participants. We strive instead to use different students' quotes within the context of each case to demonstrate how the case captures student experiences in common and to ground the broader case in PVEST.

Students' Framing of Their Experiences Through the Lens of Their Own Identities

In this section, we draw upon the demographic information and the pre-FIRED UP interviews. The pre-FIRED UP emergent codes suggest that students' prior experiences in the

discipline play a central role in the framing of their identities, and expectations coming into FIRED UP. In particular, identities around international student status, prior experiences in the field, considerations around access (physical abilities as discussed by the participants), and gender identities played into the participants' expectations around FIRED UP. Notably, not all demographic identities students held (including some student identities marginalized in STEM disciplines) were mentioned in the pre-FIRED UP interviews or discussed as salient during the program.

A total of 28 students participated in some aspect of data collection in the program. A diverse group of identities were represented within this group. We do not present these identities in tabular form due to the potential to indirectly identify participants. Many identities that have been historically marginalized in STEM disciplines and which are currently underrepresented and/or underserved were broadly present within our population (e.g., 19 students were from non-White races [Asian, Black, and Hispanic/Latinx]). Three participants shared concerns around either having a disability or having physical ability levels that could prevent their full participation in some of the proposed FIRED UP activities. Two participants identified as neurodivergent, six identified as international (i.e., not permanent U.S. residents), 4 identified as a member of the LGBTQ+ community and 7 students had various levels of prior experience in field settings. While we did not solicit mental health information for students, 3 students expressed mental health concerns.

In the pre-FIRED UP interviews, some of the identities named above were salient in framing students' expectations of the program. For the international students ($n = 6$), expectations from the program focused on developing skills that could be crucial for navigating graduate school. One student explained, *"I'm coming from a new environment, there are a lot of things for me to learn. And this program will avail me the opportunity to learn these things.... the program is going to help me build my confidence, my competence, and my networking skill."* In this instance, the student's expectations from the program were primarily determined by their international status and the contrast between the current environment with where they came from. For this student, the difference between the two environments (the United States and their country of origin) is what they expect will elicit learning. In other instances, international students also prioritized finding community in their current environment and getting to know the members of their cohort.

Students with positive associations with fieldwork or previously developed field scientist identities ($n = 7$) expressed variable concerns and expectations for the program. Some students were keen to learn more about specific ecosystems around the MRS while getting to know the different projects that their cohort members would be working on. As expressed by one student, *"I've never been to the Rockies before, so I'm really excited to be in that environment and to understand the systems that we have there. I do value interdisciplinary approaches, and I think it's important to understand what your colleagues are doing moving forward, especially in academia."* Here, the student described how the MRS could offer a unique perspective to understand the ecology around the Rockies and learn about different methodologies while getting to know their

cohort. In other instances, students expressed concerns about building an inclusive space in the field due to prior challenging field experiences. For example, one student explained, *“I also put a lot of time into social dynamics and inclusion and remembering people’s names and remembering facts about people. And so, I hope that I can be someone who makes people feel like they also have a space to be doing research and to be talking about science here.”* In this instance, for this student, fostering a sense of inclusion was an important aspect of their core value.

Considerations for access also factored into how students framed their concerns ($n = 8$) coming into the program. For example, one student explained *“I have health issues, like asthma, that make it hard for me to acclimate quickly to this kind of stuff, so I’m just going to be mindful of that.”* Another student, when discussing health issues in the context of FIRED UP, expressed excitement for the skills that they would gain, but were not sure how that would look for them given their specific health constraints. Other students in this group expressed concerns around acclimating to the higher altitudes indicating that both health and physical abilities are major concerns as students enter a program with a substantial fieldwork component.

Another aspect that was crucial in the framing of students’ expectations during fieldwork involved their gender identity ($n = 2$). One student shared, *“My biggest concern is being able to find other queer people within the department and just in Boulder in general.”* Similar to this, another student explained *“I’m really nervous to meet people and get to know them just based on some really negative experiences I had.”* Here both students expressed concern about finding community during the program and hinted at prior negative experiences around their LGBTQ+ identity. Each of these quotes enable us to see that students come into the program with different priorities and openness.

These afore-mentioned identities shaped students’ experiences and affected their sense of belonging during the program. It is also important to note that each student entering the program had differing excitements, curiosities, and concerns that interacted with various program components leading to differences in students’ sense of belonging as discussed below.

Emerging Identities: Challenges, Responses, and Sense of Belonging

The emergent themes from the mid-FIRED UP and post-FIRED UP interviews indicate that students develop case 1: a positive connection and high sense of belonging ($n = 17$); case 2: a neutral connection and low sense of belonging ($n = 10$); or case 3: no connection and a low sense of belonging or even a sense of exclusion ($n = 4$). We explain each of these cases below and situate the various constructs of the PVEST framework, that is, stress engagement (challenges); reactive coping (engagement with the cohort and community building); stable coping (sense of belonging) in the context of FIRED UP.

Case 1 (C1): Students Develop a Strong Sense of Belonging through Opportunities for Supported Coping Through Challenges, which Leads to Cohort Bonding and Identity Formation.

“It’s only been like a week, but I feel like I have a sense of belonging in a community now that I can rely on and I can use as a bounce board, to really propel myself off of, and that’s really exciting.”

In the representative quote above, the student identified that after only 1 wk into the program, they were able to find a sense of belonging and community that would be a valuable resource going into the graduate program, help them stay connected with the cohort, and make it easier to seek help from peers. Seventeen (just over half) of the participants in the program described that FIRED UP did exactly this. It enabled them to develop a strong positive sense of belonging to their cohort and start their graduate program with a sense of belonging and support from their peers and program leaders. The identities of this group were varied and from multiple diverse backgrounds. Students’ international status, gender identity, concerns around abilities during fieldwork were different aspects that impacted their experience around FIRED UP.

C1: Entering Identities and Stress Engagements. Students in case 1 entered the program anticipating that their identities would interact with the program to present exciting opportunities (e.g., an international identity presents opportunities to learn) or challenges (e.g., physical abilities may pose challenges to participation), or sometimes both. In this group, identities interacted with program components, giving rise to both opportunities and challenges. For almost all international students in this group, these challenges involved sorting out housing, arranging official documentation, and other logistics such as opening a bank account. Explaining that *“without phone, signal, and internet...it was kind of tough...”*, international students felt that the remote location of the MRS made it challenging to resolve these issues and prevented full participation in aspects of the program. However, the students recognized FIRED UP and even these challenges to be *“a good experience”* because they felt supported.

Students who expressed a lack of strong field identity experienced stress engagements that included trepidation about the field component and imposter syndrome early in the program. For example, one student who did not have a strong field scientist identity expressed, *“I’m a little nervous. I have done field work, but not long excursions like this. And the field work that I did was pre-COVID, so this was like 2018, 2019, so it’s been a really long time.”* Several students also expressed concerns around physical fitness such as, *“I don’t think I am the most fit person and it seems like there’s going to be a lot of walking around, so we’ll see how I feel after everything.”* Some students also shared such concerns and had trouble with acclimation at the higher elevation. These students expressed the need to be mindful about their individual pace during the initial days in the program.

However, not all concerns were around health and physical abilities. A few students, who had strong field identities and had prior experience with fieldwork expressed concerns about social dynamics entering the program, *“I always get worried about sort of, like, generally not fitting in whatever, be it sort of, like academically or socially. I’m a little bit stressed in that regard.”* These concerns were also shared by other students in

the group, who expressed concerns about “*sharing intentions for the program*” and finding “*a sense of community prior to starting grad school.*”

The above factors (i.e., international student status, physical abilities, and concerns around social dynamics) acted as stress engagements for students in this group. Though this group was diverse, as were the challenges encountered by these students, commonalities were identified in the coping strategies employed in response to stressors.

C1: Reactive Coping Strategies. Reactive coping strategies represent the responses of the students to the stressors (Figure 1). For this group of students, reactive coping strategies were adaptive and aligned with program goals, that is, they allowed the students to maintain their well-being and connections to the program, developing belonging. In some cases, coping with stressors even brought them close to their peers and the program leaders as they “*appreciate[d] everything, and everyone that helped in this [the challenge].*” Student quotes indicate that these coping strategies were heavily influenced by the program components, the program leaders, and their peers. This highlights the roles and responsibilities of the program and other people in supporting students experiencing stress engagements.

Participants from case 1 explained that the challenges and stress engagements encountered during the program were addressed by various program components (structured and unstructured activities) and enabled them to develop a strong sense of community. International students discussed the relative isolation of the MRS, and challenges associated with the logistics of settling into a new country. Highlighting the various challenges one international student shared “*I have to solve things like finding an apartment and opening a bank account. And so the people here are being gentle, and like offering me rides and that kind of stuff.*” Despite the challenge of being located at a remote location, support from leadership and peers such as access to Boulder via rides or sharing of experiences in the field etc. enabled adaptive coping and supported a sense of belonging and community for students in this group.

For students who expressed concerns around the physical aspects of the program, specifically hiking up to the Tundra lab (located at an elevation of 11,000 ft) during field days, intentionality around gauging their personal needs was an important reactive coping strategy. Students’ expressed concerns enabled program leaders to be mindful of some of the expectations during the activities. Thus, leaders provided multiple engagement options on field days, which facilitated a sense of positive self-efficacy and cohort bonding. For example, one student shared, “*I think I had some reservations going into it, but it’s just been so fun being able to connect with the cohort, and then getting out to go in the field has been awesome.*” This student had previously expressed concerns about the hike due to a chronic illness. The interaction of the illness with the expectation of physical exertion constituted a stress engagement but being supported by peers while attempting the hike at a sustainable pace turned into a reactive coping response. This resulted in the student completing the hike alongside their cohort, which led to cohort bonding.

Like in the example above, many aspects of reactive coping were facilitated by specific components of the program. In

another example, one workshop activity was centered around learning through failure and addressed imposter syndrome. This activity offered an opportunity for students to share their experiences around imposter syndrome with their peers. This turned into an effective segue for sharing concerns that students had coming into graduate school, “*we talked about imposter syndrome, and I think those talks are super valuable...because it’s really important to hear that everyone feels this way.*” Here, the workshop allowed the student to discover that other students shared their emotion and trepidation around graduate school. The feeling of imposter syndrome was a stress engagement and came up when students discussed feelings of anxiety around navigating graduate school. However, sharing this challenge with their peers and acknowledging others’ experiences demonstrated reactive coping in which the student recognized the value of community in helping them to navigate this emotion. While it did not resolve the emotion for the students, having community helped them to better tolerate the emotion moving forward.

Notably, in case 1, the agentic moves of the students in choosing productive coping strategies were informed by the availability of supports that could address their challenges, actions of the leadership team, and peers to offer, provide, and enact support, their growing sense of belonging in the community, and their confidence that the program and community would make efforts to support them. As explained by one student, “*the people that were in charge did a very good job. And I feel like what they intended to get across came across effectively. Especially in terms of how helpful they were and the capacity for which they wanted to help us.*” These aspects enabled the students to develop variable stable coping responses as discussed next.

C1: Stable Coping Responses and Emergent Identities. Stable coping strategies emerge from students’ experiences with reactive coping processes. If reactive coping processes are successful and useful, they are more likely to become part of an individual’s long-term stable coping responses. In turn, these stable responses and how they act within an environment, program, or community, inform long-term identity formation (Spencer et al., 1997). Students in case 1 expressed that coping with stress engagements led them to feel both supported and successful in tackling challenges and ultimately helped them to develop belonging within the cohort and EBIO more broadly. As one student expressed, engaging in challenges alongside and with the help of their peers and the program leadership would lead them to reach out to these same individuals again in the future to navigate grad school stressors, “*Just knowing that you already have people you can reach out to if you want to go grab a drink or go get lunch or just hang out and look at stars...this is a huge resource.*” Another student also expressed a similar thought that, “*having a really strong support system is really important to me, and I think having that opportunity to develop that already has been just so awesome.*” The above two quotes demonstrate that students are developing the stable coping response of reaching out to others in their cohort and graduate community for support. A student with prior field experience but initial inhibitions about finding community shared, “*I feel like I’ve found some people that I really share a lot with that I’m excited to build relationships with outside of*

FIRE UP and going into grad school with.” This quote shows their emerging identity as a member of their cohort through FIRE UP and points to how they see themselves connecting to their peers.

In other instances, where students expressed concerns about physical abilities due to chronic illness, support from peers and program leadership led to a strong science identity as expressed by *“being able to get up to the Tundra Lab, I felt so proud of myself and it made me feel more confident personally in that sense of hobbies, but also professionally in the sense that I feel more confident going into the field that I can physically do that stuff.”* It can be noted that for students in case 1 their growing sense of belonging in the community emerged as significant elements of their stable coping responses and their emergent identities.

Summary of Case 1. Students in case 1 shared the experience of finding that the coping strategies they chose and/or were encouraged to pursue when engaging with stressors led to what they felt was successful resolution or acknowledgment of their individual challenges. This in turn led to deeper bonding and affiliation with the leadership and peers. Salient identities mentioned by this group interacted with the program to give rise to stress and included being international, having anxieties around graduate school (academic and social), not feeling like a field scientist (yet), and having differing physical abilities compared with one’s peers. As indicated by students in this group, stressors could be logistical, physical, emotional, or social. Notably, the program supports and components contributed to either a successful resolution of the stressor or a way to tolerate the stressor. For these students, there was evidence that an emergent identity as a member of their cohort and the broader EBIO program was developing. However, not everyone in the program developed strong connections with their cohort. We identify this owing to different stressors and the responses and available support from the program, leaders, and peers during the reactive coping process.

Case 2 (C2): Late Entrance, External Obligations, and Logistical Challenges lead to Lack of Strong Cohort Bonding and Low or Neutral Sense of Belonging.

“I think it’s still not much below the surface-level connection, but it’s nice to have friendly faces that I’ll know in the department now”

In the above quote, the student recognizes that the connections they built during FIRE UP were surface level while acknowledging that meeting peers prior to the start of the graduate program would be “nice” as they enter the graduate program. These feelings resonated with 10 (around one-fourth) participants who expressed a lack of deep connections during FIRE UP. The lack of connections was attributed to various factors by the students, such as joining the program later, concerns around field work (navigating social dynamics or elevation), and external obligations (such as sorting out housing, etc. or prior academic commitments). These factors presented various stressors that needed to be resolved and prevented full participation in the program leading to a low sense of belonging.

C2. Entering Identities and Stress Engagements. Students in this group either joined the program later, had concerns around social dynamics or elevation, and frequently had external obligations (such as sorting out housing etc. or prior academic commitments) that competed for time with program components leading to a low sense of belonging. Unlike case 1 students, however, interactions of student identities with program components either gave rise to logistical challenges which separated the students from their cohort or had a neutral effect that did not lead to bonding. Notably some students in case 2 clarified that they did not feel a sense of exclusion—rather, it was a lack of connection. For example, one student shared about their peers in the program, *“I think sometimes I feel like they have known each other for a long time. And that’s not true. And because they were talking about scientific stuff, so fluently. And I remain silent for most of the details. But I have to work on that. And it’s more like a personal thing. I know that I’m not being excluded. That is something that I have to work to kind of surpass this barrier.”* In this instance, the student did not feel excluded by their peers but described the lack of connection as a personal barrier that they would need to navigate.

A major stress engagement in this case was that students sometimes joined the program part way through. Both in Y1 and Y2, there were several students who joined FIRE UP late (i.e., in wk 3 in Y1 and wk 2 in Y2) for a variety of reasons such as starting their graduate program after finishing up their master’s and overlap with conference dates, etc.

One student who joined later felt that integrating into these already established relationships required more energy and input and felt that *“the people that had been there at FIRE UP the whole time were a little burnt-out and their social batteries were pretty low”* so they could not effectively engage with the newcomers. Out of the 8 students in case 2, six were students who joined the program late in Y1 or Y2. In interviews, none of these students mentioned their marginalized identities as playing a role in their perception of the lack of connection with the program or other students, despite many of these students holding such identities. Instead, they attributed their experience to the logistics of joining late and having not been present for the initial cohort bonding.

Some of these stressors were situation specific to individuals who had obligations or responsibilities outside of FIRE UP. One international student felt distracted due to the logistics of getting set up in a new country and their inability to fully participate in the program. Unlike students in case 1 who requested help, this student navigated international challenges on their own. It was unclear from their interviews whether they felt as though they could not ask the program for support or preferred to work on things alone. Other students with identities as current graduate students, for example people finishing up their masters, were trying to engage in the various components of the program in addition to meeting other academic deadlines. This required more effort and created a situation in which students often had to choose between competing priorities. For example, one student described, *“some of us are trying to finish up our master’s stuff. There’s a few hours scheduled downtime [in which we can work], but because this I feel is a pretty intense program, I’m too tired at night to finish any of it [the master’s work]. And I don’t want to be left out from the cohort activities.”* On the flip side, students who came in

with a master's degree and had been exposed to prior research or fieldwork experience described that some of the FIRED UP activities felt repetitive or unaligned with their goals. *"The day where we talked about how to read scientific papers, was a lot of review for me and then the two field days were fun, but not necessarily useful for my professional goals,"* and as such, they did not experience the intellectual engagement they wanted out of the experience.

From these examples, we note that students who have an existing set of academic goals with associated deadlines found it difficult to fully immerse themselves in the program. International students in this group further discussed that it was distracting for them to fully focus on the program when they had logistics of accommodation, banking, etc. to be sorted, which was difficult due to the remote location of the program.

Other stressors for students in this group included concerns around the program's high elevation and social dynamics. For some students, the structured activities acted as a stressor and one student described that, *"I have [a mental health condition] and I just need 5 to 10 min where I have my own time every few hours."* Another student resonated with this thought and expressed concerns around FIRED UP being "too regimented" to accommodate their needs. In both examples, the highly scheduled and structured nature of the program interacted with identity and needs to form a stressor. Other students expressed concerns around the social dynamics and explained, *"I came in being worried about maybe social dynamics just because it's a group of people who don't know each other, and maybe there could be some cliqueness involved."* These examples demonstrate that a combination of program components and aspects of individual identities led to stress engagements that primarily presented as distractions, sense of overwhelm, or lack of opportunities to engage with peers.

C2. Reactive Coping Strategies. Students in case 2, expressed that coping with the specific stressors led them to respond in ways that did not result in relationship formation, and ultimately, hindered or slowed development of a sense of belonging. One student (Y1) joining the program after 2 wk did not perceive opportunities to bond with their peers and pointed out that, *"there are some groups forming and people sometimes tend to spend more time together. I don't feel like a part of any group [but] I feel welcome. I don't think like I have any quarrels or anything with anyone."* In this instance, the student described the social dynamics that arise when people spend time together and the complexity when new people enter an established social space. This student and others who joined late perceived that their peers were already close to burn-out and did not have much energy to engage in relationship building activities. They chose not to "force" others to interact with them in deep or complex ways as they perceived this would be stressful for their peers, and as a result, they did not feel a sense of cohort bonding. They commented that *"we have to devote more social energy to trying to include new people into that atmosphere when bonds are already established."* While the coping strategy of maintaining only "surface-level" conversations helped the newly entering students to avoid stressing their peers and eliciting awkward interactions, it did not facilitate a sense of deep belonging with their cohort.

Other stressors that were present as distractions sometimes led students to distance themselves to tackle these situations. For example, one student who also entered the program later commented that *"I just think that with the combination of everything going on outside of academia in my life, and then interacting with these students who had already kind of established their own friendships was too much."* This student described how they did not have the energy to engage with others given external stressors. Their solution to this was to withdraw socially so that they could maintain the energy to cope with the external situations causing them stress (i.e., they avoided the social stressors of engaging with the program). In this case, the situational factor of joining the program later than their peers may have contributed to the student's decision to pull back. This decision, which in the short term allowed them to maintain some well-being and give energy to other aspects of their life, ultimately hindered relationship formation and development of a sense of belonging.

The student's experience above is somewhat similar to other students with external academic obligations that were competing for their time. These students responded to external pressures by allocating downtime to their external obligations instead of spending it with their peers. Overall, this allowed these students to advance their academic identities and achievements, but this coping strategy came at the expense of furthering their cohort bonding and sense of belonging to their new graduate program. The duration of the program was reduced to 2 wk in Y2 to help address the issues above (i.e., to avoid burn-out and avoid competing with other obligations).

C2. Stable Coping Responses and Emergent Identities. In the previous section, we noted that the stress engagements case 2 students faced often led to distraction, disengagement, and lower sense of cohort belonging. Students in case 2 explained that they did not feel that the program, their peers, or the leadership could have done much to change their experience, but that they had not developed strong relationships, nonetheless. One student who experienced stressors when sorting out accommodation logistics, explained, *"everyone was super welcoming and nice, but I don't think I developed strong friendships with other people. But it was still a very good way to just start my PhD and feel like I was part of the community and kind of ease in."* Despite not developing a strong sense of belonging within the specific cohort, the student recognized the value of participating in FIRED UP. Their last statement *"part of the community,"* indicates that, for this student, an emergent identity is a feeling of community with the broader EBIO community that may continue to grow despite lack of connections with their specific cohort.

For other students, the external nature of their challenges in combination with the program's inability to support the student through the challenges (difficulties that were out-of-state, highly personal, or highly unique) caused them to intentionally disengage from the FIRED UP cohort or caused unintentional distancing after the program, but they did not see that as a bad thing necessarily. For example, when discussing being connected to other graduate students in the post FIRED UP interview, one student acknowledged that their connections had decreased since the program, but expressed that they were OK with this since they did not have the energy or

time to connect, “I think it’s a normal thing, that they are connecting in ways that don’t make sense for me. I don’t have the bandwidth, so we’re fine.”

Summary of Case 2. Students in case 2 share the experience of encountering stressors that they perceived as arising from outside the program (e.g., graduate obligations) or that arose due to logistics of the program (e.g., arriving late or the isolation of the MRS). Their stressors caused them to cope by disengaging during potential times of cohort bonding either because the program could not offer supports for their stressor (e.g., the program was not designed to support time for other academic deadlines) or because they perceived that asking those in the program for support or engagement might not ultimately be productive (e.g., they perceived the burn-out of peers and leadership when joining late). Notably, these students did not feel excluded from the program and described their lack of cohort bonding as “owing to the circumstances,” often attributing it to being beyond their or program leadership’s control. For these students, there was no evidence that an emergent identity as a member of their cohort was developing. However, there was occasionally evidence that they felt they belonged more broadly to EBIO. Intentions to continue to engage with the EBIO community were expressed by students in this group and intent to continue to engage with their cohort was mixed.

Case 3 (C3): Stronger Interactions Between Programmatic Elements and Student Identities Lead to Barriers in Student Participation Resulting in Low Belonging and in Some Cases Sense of Exclusion During Participation in the Program. Owing to the small sample size represented in this group, we use quotes from all four participants in this case to highlight the complex interactions between various aspects of the students’ identities and components of the program.

Quote [1] “I did not feel I was able to participate in everything. And I would have liked to have been able to participate in more.”

Quote [2] “I wonder if having more small group opportunities for people to talk about their queer identities or disabilities or any of the other... I found that challenging because it seemed like my neighbors just couldn’t.... It could just be the people that I ended up with, but it felt like I would try and talk about the things that I was thinking about, but then there was just complete silence and they wouldn’t really say anything. And then they’d go back to talking to each other...because I did say... I talked a little bit about how I’d had a lot of challenges in terms of identity...and then they just sort of were very... just didn’t say anything to that, and then started talking to each other. And I think I felt a little isolated.”

Quote [3]: “But because I [hold an identity and external obligations not commonly shared] and I come into it [FIRED UP] wanting to keep my [external commitments and fulfill my external obligations]... I understood that [FIRED UP] was optional, I mean, honestly, it’s one of those things where it’s optional on paper, but I think it’s just bad form not to show

up [to FIRED UP]. So if I had to be frank, yeah, there’s a pressure to show up [to FIRED UP] because you’re going into this cohort.” Later in the interview this student expressed “sometimes it’s a little harder for connections to happen because we are at such different places in our lives that it’s very delicate”

Quote [4], “...the fact that there was no cell phone service and lots of downtime, I felt not only disconnected from the support system that I had at home, but like, the way to entertain myself was either sitting in a cabin, by myself, like very isolated, or interacting with a group of people that I didn’t necessarily have the energy to do that with, and to follow them around and stuff like that.”

The representative quotes above highlight that some students felt they were unable to participate in all the activities of the program despite wanting to (Quotes 1 and 2) or felt distinctive pressure to participate in the way that seemed uncomfortable to them (Quotes 3 and 4).

In this group, participants expressed a sense of exclusion due to program components that were aggravated due to their individual identities. Four (one-seventh) of the participating students expressed sentiments aligning with this case. In particular, students in this group had varied identities (racial, ethnic, gender) and explicit concerns around health and disabilities. They described how FIRED UP either aggravated their feelings of exclusion or pressured them to participate, causing them to put aside other aspects of concern in their lives. When the students in this case were interested in participating more, aspects of the program were not conducive to their full participation. This was due to multiple factors such as lack of peer support (or relatability with other members of their cohort) or issues around health and well-being. It is also important to note that, due to the various challenges, the students in this group could not necessarily participate in all aspects of the program (e.g., a student departed from the program early and others opted-out of specific parts of the program, etc.), some of which facilitated cohort building. Participants in this group discussed that the support from the program was not enough to meet their individual needs as discussed below.

C3. Entering Identities and Stress Engagements. Students in case 3 experienced a sense of exclusion due to lack of programmatic components that could support their identities. The feelings of exclusion also intensified due to what the students described as a lack of program leaders’ initial awareness regarding how to support these individuals’ needs as well as a lack of needed resources that could support their needs and cohort bonding at the same time.

Students in this group expressed a sense of exclusion using descriptions such as “feeling lonely,” “missing out on bonding opportunities.” One student highlighted how some of the challenges they faced were unique due to their physical health, “I feel like some of the challenges that I’m going through feel pretty unique to me, with maybe the exception that [my peer] is also experiencing a few of them.” This student further shared that some components were inaccessible due to their physical health. The interaction of health constraints and the location of the program (high elevation, field work) resulted in the

student being unable to fully participate in some program aspects, which caused a stress engagement of being separate from the group. They also recognized similar challenges faced by a peer.

Another student, who mentioned experiencing chronic and acute mental health challenges, echoed some of the sentiments expressed by students in case 2 about entering the program late. They explained, *"I felt intimidated by the friendships that were already made that I would have to take more energy to push myself into, because they've kind of already not necessarily closed themselves in, but [they are] comfortable [with one another]"* Unlike those students in case 2 who arrived late and coped by engaging at a "surface level," this student "didn't necessarily have the energy to [engage with others]" and expressed that they felt isolated.

Another student who held two intersecting historically marginalized identities discussed that their willingness to have more discussions with their peers around challenges faced by them were not reciprocated leading to feelings of isolation. Unlike students in cases 1 and 2 who found strong to moderate peer support, the lack of peer response made this student feel isolated which caused a stress engagement of being separate from the group. Finally, several students discussed a certain pressure to participate in the program. A student with external prior commitments experienced the expectations around full participation in the program as a stressor.

For students in case 3 many components of the program such as fieldwork, the visit to the high elevation Tundra lab, and the unstructured time after dinner when students often elected to engage in social and physical activities, were not accessible. Due to aspects of the program interacting with these students' identities (e.g., long-term health constraints, gender identity, persistent mental health conditions, and intense external obligations), these students were often provided individual housing or other accommodations such as flexibility to participate in a few specific components of their choice, which allowed them to attend to their health, but led to further isolation and exacerbated that stressor.

C3. Reactive Coping. Students in case 3 mostly experienced stressors that were intimately related to acute interactions of the program design with their identities and with ongoing challenges with which they were coping. The reactive coping responses in case 3 were often the result of a combination of program components, students' choices in how to engage, and accommodations or supports the program provided that, unfortunately, could only partially address aspects of each stressor for these students.

For example, one student left the program to attend to their well-being. They explained how a situation that had started before the program interacted with the program location and caused them to feel exposed to their peers, *"a lot of times if I was doing unwell and needed to call somebody, I was crying in front of people. Which happened a handful of times... Which made it harder because I was already like, I'm already establishing this stigma about me that I'm very emotional, which may or may not be true, but it was not one that I wanted to bring up so quickly."* The stigma of coming across as an emotional person during personal calls (cell phone service was only available in public places) in combination with the lack of access to a home

support system led the student to leave the program after only a short period of attendance.

Students in case 3 described accommodations the program leadership had made (e.g., an individual cabin as opposed to a group 1, and allowances for time apart from formal activities). In their descriptions, it was clear that accommodations often allowed students to maintain a degree of well-being by avoiding exhausting social situations or risking their health. However, the accommodations presented a duality with opposing positive and negative effects; the accommodation often resulted in isolation from the group. Thus, the students frequently disengaged or left. Ultimately, this coping mechanism prevented relationship formation and development of a sense of belonging during the program.

Two students in this group described feelings of exclusion and isolation specifically when getting to know their peers. One student in this case noted *"nobody has really been outstanding, really making that effort for me consistently in the amount of time that we've had."* Similar to the feeling reflected in Quote 2 (case 3), this student points toward the lack of intentionality in efforts toward reciprocating their specific concerns. Both these students responded by distancing themselves from their peer cohort and instead sought for support from program leaders. It is interesting to note that for both these students, learning to navigate their specific health situation with the program leaders was an important outcome of their participation in the program. However, because the available accommodations separated them from the group, they again held a duality with opposing positive and negative effects. The overall effect of receiving support from the leadership improved their physical and mental well-being while participating in the latter half of the program but could not address the lack of belonging the students experienced. The student who described a certain pressure to participate in the program used the term "acquaintanceship" and recognized that, *"there is value in getting to know the members of my cohort because I know that we are going to have to reach out to each other"* but at the same time distanced herself from the cohort to some extent as a reactive coping mechanism to attend to the external pressure. Ultimately, this prevented development of deep relationships.

C3. Stable Coping and Emergent Identity. Students in case three entered the start of graduate school with convictions that future coping responses would require self-advocacy and self-reliance. Their experiences during FIRED UP confirmed for them that the support they needed was beyond the capacity of FIRED UP leadership, and by extension, their graduate department. One student explained that *"grad school is going to be a thing that I do on my own. And the support that I need, I'm going to have to find somewhere else, because the people from FIRED UP are not... they are not going to be able to fulfill - not maybe because they don't want to - maybe because they can't fulfill the needs that I have, so that I can be okay."* The stable coping mechanism emphasized here is self-reliance.

Two students described that their experience during the program and the faculty support they received enabled them to identify aspects of self-advocacy pertaining to navigation of their graduate school experience. As explained by one student, *"I think it was helpful for me to be able to connect*

with [a member of the leadership team], which turned into a conversation more so about what that might look like for the academic year and maybe how I should start navigating things with the department. Another student explained that she established healthy boundaries that would allow her to make progress, “I’m at a little bit of a different place now than I was at the very beginning of my career; right, I’ve met everybody and established certain boundaries.” This student ultimately expressed that their self-advocacy assisted in fulfillment of some needs. Self-advocacy and boundary setting are expressed as stable coping mechanisms that both these students choose to employ. Both self-reliance (described in the paragraph above) and self-advocacy are generally viewed as positive and may lead to a sense of perseverance and resilience depending on the outcome. However, if a student pursues self-reliance or constant self-advocacy as a sole or main coping mechanism, it could also result in a continuation of feeling separate, a lack of belonging within the cohort, and exhaustion.

Students in this case commonly recognized that they would need more than the FIRED UP community to navigate graduate school and clearly expressed that their stable coping mechanisms involved having conversations with various members of the faculty and other support entities across campus to further understand the process of navigating the graduate degree. Namely, though, none exited the graduate program after FIRED UP, despite their sense that aspects of the program had excluded them. One student expressed in a post-program interview “There have been a few students who I have connected with and liked and really felt like they are cognizant and intentional people who, hopefully we’ll be good friends for the rest of my graduate program,” demonstrating optimism and that, despite not forming a sense of belonging during FIRED UP, students may be able to develop this after the program.

Summary of Case 3. Students in case 3 shared the challenging and important experience of finding that the coping strategies they chose, or which were available/provided to them to employ when engaging with stressors had dual impacts. While partially supporting their well-being, these coping strategies resulted in different degrees of isolation from their cohort and led to feelings of exclusion, lack of community building, and absence of sense of belonging. Salient identities that interacted with program components and the environment in this case included physical ability, mental health, LGBTQ+ status and nontraditional career stage. Stressors were physical, emotional, and social, as in the first case, but were experienced with much greater intensity by students in case 3. For these students, a realization that self-reliance and self-advocacy would be useful stable coping mechanisms moving forward was paramount.

DISCUSSION

Students historically marginalized in STEM disciplines (incoming identities) are exposed to different stressors around stereotyping and biases (stress engagements) when in the field, and due to differences in cultural norms and values, they may face barriers in learning (O’Brien et al., 2020; Demery and Pipkin, 2021). An immersive field program like FIRED UP in a remote location presents a context where

students engage with various external stresses. Specifically, students with health issues or disabilities may face different or more acute barriers to participation (Atchison et al., 2019). In such cases one potential stable coping response could be disengagement from future field research and an emergent identity could be the realization that they are not a field scientist. On the other hand, students who experience support could emerge resilient, feeling a strong sense of belonging to a field-based community, and with a likelihood of increased engagement and affiliation with field disciplines. We discuss how both of these outcomes emerged from FIRED UP.

Identity Influences Expectations and Interacts with Program Design to Influence Experiences in Vastly Different Ways

While FIRED UP had two specific goals including field training and community building, we have focused on the latter here as this is more relevant for the context of access, equity and identity as described by the call for this special issue. Prior research findings suggest that field experiences play an important role in the development of a disciplinary identity and may influence field research self-efficacy and sense of belonging (Baber et al., 2010). It has also been established that field experiences may have nuanced impacts on students based on their identities (Fairchild et al., 2022). In this study, we note that identity influences expectations and interacts with program design to influence student experiences in vastly different ways. Most notably, we identify three distinct cases where students indicate a strong sense of belonging, a neutral or low or sense of belonging, and no sense of belonging or even exclusion from their cohort.

For most students, the program supported community building and a sense of belonging. The 17 students in case 1 specifically reported that the program design and location interacted with their identities (e.g., international, physical ability, gender) to present challenges that led to a deeper sense of connectedness and allowed them to form relationships with peers and program leaders. Most participants in case 1 were present for the full duration of the program in both years. In coping with the challenges, students in case 1 reached out to peers or leadership and were met with support and potential solutions that aligned with their needs and affirmed their identities. They collaborated with peers and program leaders within the field context resulting in productive responses. They described their interactions during challenges as contributing to a sense of belonging because their needs (that aligned with their identities) were empathized with and supported. We also noted that students who had opportunities to build and maintain peer relationships in the field were able to navigate these challenges while also maintaining their well-being and remaining engaged, which aligns with findings from prior research (Jolley et al., 2018; Stokes et al., 2019). Fieldwork can present diverse stress engagements that may relate to accessibility, science skill, and social interaction (Jolley et al., 2018; Stokes and Boyle, 2009). The intense nature of fieldwork can be daunting and mentally stressful (Giles et al., 2020; Mogk and Goodwin, 2012). Repeated exposure to stressful situations in the field can exacerbate feelings of imposter syndrome and can impact how students navigate their graduate school

experience. While the seventeen students in case 1 experienced many diverse stressors similar to those described in prior work, they emerged with a stronger sense of belonging after having been supported in developing adaptive coping strategies that either allowed them to resolve or tolerate stressors. It is worth noting that the sociocultural context of field training cannot be separated from the students' individual circumstances and greatly impacts their overall engagement and experience during the program. For instance, students in cases 2 and 3 had a different experience. Prior work described how long hours, remote locations, and health constraints can present various barriers to participation during fieldwork (Ward *et al.*, 2021). Some of these perceived challenges can be aggravated or alleviated depending on factors such as program design, environment, group dynamics, and leadership (John and Khan, 2018; Malm, 2021). While for case 1 students, group dynamics, environment and leadership helped to alleviate challenges, students in the other cases (2 and 3) often found that these factors exacerbated challenges and led to distraction or even exclusion. For students in case 3, stressors were almost always influenced by a strong interaction of the program and/or environment with identities and associated needs. For example, a student from case 3 described how the environment and design, which included strenuous physical engagement, interacted with their health to aggravate challenges and exclude them. However, in their case, reaching out for one-on-one support from program leaders alleviated some challenges, which aligns with prior findings (John and Khan, 2018). Students in case 2 also experienced identity by program interactions (e.g., international, being a current graduate student), but the interactions were not described as intensely for those in case 2.

A notable finding that enabled revision of program design in Y2 was that multiple students in case 2 and one student in case 3 commented that joining the program later in Y1—an element of program design initially intended to make the program more inclusive and flexible—created a dynamic in which they did not identify with students who had already been at the field location for prior weeks. Most students described this as something that could not be helped, and strived to engage in ways that supported their peers. However, one student who held a stigmatized identity associated with their mental health experienced this design element as exclusionary due to the high social activation energy required to participate fully. These students protected their well-being and preserved their energy as it was needed for other purposes. For late-joining students, the flexibility allowed them to complete other tasks or accommodate their work/family commitments, but subsequently resulted in a missed opportunity to bond with their cohort early on. This was surprising to us as flexibility is typically couched as inclusive in field settings (Stokes *et al.*, 2019; Jensen *et al.*, 2021). It begs the question of how accommodations such as these might act in unintended ways, especially when interacting with stigmatized identities.

Another interesting observation from students in case 3 was the use of self-advocacy as a stable coping mechanism that improved well-being, and ultimately connection with the broader graduate department. Indeed, research has shown that self-advocacy can have a positive impact such as higher GPA, etc. particularly for students with disabilities (Pfeifer

et al., 2020). Presenting opportunities for students to engage in self-advocacy during field work (e.g., mid-session invitations for feedback and subsequent revision) may be useful when leaders cannot anticipate all challenges students may face, but this must be balanced with the understanding and expectation that not all students will self-advocate and that we should not place this expectation on students. Indeed, findings from Pfeifer and colleagues (2020) indicate that the ability to self-advocate is a skill developed over time and often due to exposure to challenge and unideal circumstances, particularly for students with disabilities.

Our work adds to the existing literature on interactions between identity and field program design in two important ways. First, it provides specifics of how identities interact with fieldwork in a graduate school model. While several published field course designs focus intentionally on scaffolding learning experiences in the undergraduate setting (Easton and Gilburn, 2012; Morrison *et al.*, 2020) it is important to note that in the graduate setting some of the identities that students hold may be unique or more likely to be represented in graduate cohorts. For example, international students' participation in a remote field program can be challenging not only due to the different context of the fieldwork (which can mean differences in food, comfort in place, etc.) but also because there may be other aspects that they may be trying to resolve (such as sorting out paperwork, etc. when moving to a new country). Similarly, students who come from a master's program or have other external obligations, may have different goals, or academic timelines making it difficult to balance prior commitments with an involved and physically demanding field experience.

Second, our work highlights that students who are often assigned (by society) to the "category" of historically excluded, underserved, or underrepresented can have vastly different experiences. For example, in our work, students who fit the UNCRPD (United Nations Convention on the Rights of Persons with Disabilities, i.e., any long-term physical, mental, intellectual or sensory impairment which, in interaction with various barriers, may hinder the full and effective participation of disabled people in society on an equal basis with other) had experiences aligned with case 1 and case 3. We refrain from listing the disabilities expressed by the students to protect their confidentiality. Likewise, different international students described experiences aligned with those of case 1 and case 2. Categories that are assigned to students based on their expressed identities were not consistently associated with outcomes a student had as a result of participating in FIRED UP. Instead, we observed that multiple contextual factors (e.g., environment, specific timing, activities) interacted with the nuances of students' many identities to influence outcomes. Notably, solutions to challenges that worked to promote inclusion often accommodated multiple challenges and aspects of a student's identity (e.g., an international student traveled back to Boulder for a day with a program leader to solve housing issues and purchase food that better suited their nutritional needs). However, when solutions did not accommodate multiple needs or intersectional identities (e.g., individual housing due to health precautions in the time of COVID lead to exclusion from informal group activities), the goals of the program were not met, and stressors persisted or were only partly alleviated.

This aligns with work on intersectionality which urges us to reject monolithic descriptions of individuals in favor of more complex understandings of who they are (Cho et al., 2013; Sparks, 2017). Indeed, several identities that have been historically marginalized in STEM and were broadly present within our population (e.g., 19 students identified with a race or ethnic group historically excluded [Asian, Black, and Hispanic/Latinx]; 4 students identified as LGBTQ+ and 2 students had disabilities) were not discussed as salient within the FIRED UP setting while other aspects of these students' identities were strongly influential. This again demonstrates that salient identities emerge as influential from a combination of environment, identity, and interpersonal interaction. Regardless, while a lot has been said about access and equity in fieldwork (Shinbrot et al., 2022; Ward et al., 2021), we note that equity should also mean that learning opportunities should be maximized for all students. Thus, thinking of context for designing a graduate level fieldwork program to foster belonging is crucial and requires adaptability as is discussed next.

Adaptive Solutions to Stressors in Field Disciplines may Require an Integrated Systems Approach that Challenges Norms and Integrates Efforts from Students and Program Leadership

In this manuscript, we investigate our data using PVEST, and discuss our findings in the context of the various elements of this framework such as incoming student identities (risk contributors); stress engagements (the field program elements); reactive coping methods and stable coping methods (responses to stressors) and emergent identities. While PVEST is specifically focused on an individual's development, it is grounded in the ecological approach to social systems described by (Bronfenbrenner and Morris, 1998). This approach can be instrumental in understanding the nuances that influence educational and career pathways of underrepresented students (Spencer et al., 1997; Wolfe and Riggs, 2017). It highlights the role that the "social ecosystem" plays in student success. Bronfenbrenner recognizes that an individual's development is influenced by multiple interconnected levels of systems that include a person's close friendships and family (microsystem), their professional acquaintances and affiliations with different entities (mesosystem, e.g., workplace, school, neighborhood), and broader cultural and environmental influences (exosystems and macrosystems). This ecosystem-based approach to thinking about field programs can maximize access to learning opportunities for all students by enabling us to interrogate how multiple factors interact with student identity to result in outcomes and alleviate barriers to participation. It also helps us recognize that successful integration of responses from multiple levels of social systems are necessary to successfully support students during the reactive coping stage in PVEST.

Using PVEST enabled us to view how interacting aspects of culture, support systems, and place influenced student experience. For example, students were challenged by one component of FIRED UP which involved a hike up to the Tundra lab located at an elevation of around 11,000 ft (place/exosystem). The expectation of physical exertion and toil is a cultural component of field work that can lead to exclusion. Expectations on hiking in particularly difficult terrains can sometimes act

as barriers to learning and participation, and the physical element of fieldwork can even make students with disabilities reconsider a future in field-based disciplines (Stokes and Boyle, 2009; Stokes et al., 2019). We observed this exclusion in Y1 as more than one student elected not to attempt the hike due to how it was framed to the students as a highly physically challenging experience (social mesosystems). This led to a missed opportunity to bond with others. Thus, in Y2, program leaders (social mesosystem) agreed to be explicit about having multiple levels of challenge around the hike and to both discuss and model that it is okay to rest and pace oneself during the hike. Leaders discussed the importance of field safety and the unhelpful and unsafe culture of scientist showboating in the field (cultural macrosystem), while including discussions of how to be honest and self-aware about one's own and capabilities and acknowledge others (microsystem) on a given field excursion. This openness from the leadership was extremely well received by all participants. Indeed, as described in case 1, one student who had prior concerns about the hike shared that it increased their belonging because it made them "proud of myself," and "more confident" both personally and professionally. During the hike, this student felt supported in setting physical boundaries and responded to advice. They frequently rested with leaders and other peers.

This is one example of many that illustrates how the leadership team and the students worked together within a logistically limiting system, to challenge cultural norms and expectations of conduct within the field. This interaction, students working with instructors and sometimes campus support staff to navigate or push back against cultural norms occurred at multiple stages during the implementation of the program when stress engagements around international student housing, suitable food availability, and imposter syndrome arose. Notably, the success of this and other instances involved successive interactions of the students themselves, their microsystem (students' friends often took actions to support them), the mesosystem (the leadership changed program design or actively worked to modify program culture), and the exosystem and macrosystem (the physical environment and safety were discussed and responded to in the moment to promote safety and comfort). In this study, we found it of particular note that actions to solicit student feedback mid-program originating from the program leaders (i.e., mesosystem), were instrumental in enabling students' agency in self-advocacy and productive reactive coping responses. Largely, these instances supported student belonging.

While we considered students' "sense of belonging" a success, we also acknowledge that this was not always the case. In some cases, students expressed that there was a disconnect between their needs, the program and culture, and what leadership could provide (or what they perceived was possible given the environment). In these cases, interactions between the systems broke down and adaptive solutions did not fully support the student. For example, several students had a need to be physically separate from others in certain contexts due to a variety of health concerns. Though accommodating for their health, this frequently created a disconnect between the student and their micro and mesosystems as developing friendships were hindered. A disconnect between students' microsystems outside of FIRED UP (close family or friends)

also occurred due to the remote location and lack of consistent cell phone service. These disconnects were sometimes addressed, but in other cases they were unable to be changed. Structural barriers, personal circumstances, and waning motivation to solve a problem resulted in disengagement, exclusion, and ultimately no or low sense of belonging. Our observations emphasize that successes are often enacted through a dynamic systems approach (Bronfenbrenner and Morris, 1998). The leadership, the students, and the environment—to include institutional support structures—must be “on board” to support inclusion and challenge cultural norms. None of these factors acts in isolation. Prior work has described how these factors are relevant for scholars of color (e.g. Skoglund and Stäcker, 2016; Flinn, 2016) but they can also be applicable for other minoritized identities and groups, as in this work.

Holding a Dialectic: Implications for Diversity, Equity, and Access in Graduate Education and Opportunities for Growth and Reflection

Our results illustrate that FIRED UP supported a majority of incoming graduate students—most from historically underserved groups—in developing a strong sense of belonging to their cohort and identifying as members of their discipline. At the same time, the program was unable to attend to all students’ individual needs. How do we “hold the dialectic” that the same things in the program that led to cohort bonding, sometimes also excluded individuals? How do we use the program’s constraints as a tool for reflection and growth that can inform the design of programs intended to support community building specifically in a field environment? What are the considerations for maximal equity, and is it attainable? In a study on accessible fieldwork, Stokes (2019) found that principles that make fieldwork experiences more accessible and equitable come down to good practice and adaptability. Our results demonstrate that the various components of the program are more likely to foster a sense of belonging when the program is adaptable to the needs of the students, when students and leaders coconstruct solutions, and when unhelpful cultural norms are explicitly challenged. However, we also noted that the program’s efforts to encourage flexibility and adaptability sometimes led to students feeling excluded.

Given our results we advocate for holding a dialectic, that is, we hope to advocate for exploring, embracing, and holding apparently contradictory but equally valid positions without trying to reconcile them. In doing this we can recognize and value what is working in a program while also learning from aspects that do not work, or function in contradictory positive and negative ways. FIRED UP worked to inspire a broad sense of inclusion and belonging within incoming grad cohorts but also made several students feel excluded. It must be noted that students who felt excluded could not fully participate in all components of the program (both structured and unstructured) and thus missed several opportunities to build strong connections. From the program design perspective, while adaptability and flexibility to accommodate students’ needs is worth pursuing, we need to interrogate the options we offer when adapting programs. Will the options unintentionally exclude or isolate students? The ability to “opt-out” of activities may be important to maintain students’ health but can create tensions regarding belonging and may require more

creative solutions (see recommendations). Though some students felt excluded, FIRED UP was able to foster belonging for many students, especially students marginalized in STEM disciplines. This can be considered a success, especially compared with inaction, and can be leveraged to inform broader efforts to include more diverse scientists.

The more we successfully attract and encourage students from diverse backgrounds to apply and attend our programs, the more we will need to work to understand their needs, create inclusive environments, and strive to support long-term positive, stable coping responses. It takes a village, a community, and a commitment to discipline. Beginning this work is a commitment to constant change and innovation.

Based on our findings, we suggest the following recommendations for designing field-based coursework.

1. State components of the program as clearly as possible in advance so that challenges can be anticipated by students. Do not overstate or understate the level of challenges, aim for accuracy and transparency.
2. Invite students to share anticipated challenges, but also recognize that many challenges will be unanticipated.
3. Plan ways to challenge and change cultural norms that give rise to exclusion.
4. Create capacity for flexibility in the program design by providing multiple and varied options for engagement in field activities; strive to avoid creating hierarchies of activities that create privilege and marginalize.
5. Critically interrogate “flexible,” “alternative,” and “accommodating” options offered to students with diverse challenges and needs. Ask what trade-offs these options will enact and invite students to participate in designing options that work for them or choosing between options when possible.
6. Recognize and create opportunities to support the emotional, cognitive, and physical loads experienced by both participants and leadership of the program and recognize the need for downtime and breaks—both to accommodate the need to rest and to accommodate other obligations students may have.
7. Meet challenges with compassion and acknowledge that not all proposed solutions will solve a problem.
8. Connect students to external support structures as needed and recognize that this may be critical to support student well-being.
9. Work with campus support systems to enact solutions but recognize that campus offices may not be prepared to respond or provide support in the field or other unique settings. Work to build institutional memory of what works in these new environments.
10. Actively recognize that both successes and failures of programs depend on the availability of relevant resources and support systems in addition to engagement of students and program leaders.

A dynamic systems-based approach can be instrumental in bringing positive impacts to facilitate access to education—particularly in field environments. We hope that this work raises awareness of some types of experiences graduate

students might encounter in field-based training programs and allows for more informed graduate program design.

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