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ABSTRACT

Undergraduate summer field programs are valuable experiences that can foster or reduce students' self-efficacy, an important factor in students' success and retention in geoscience. Growing research findings show that science field experiences can be hostile and unwelcoming to students with marginalized identities, which may negatively impact their self-efficacy in geoscience, a discipline with a dearth of students from underrepresented, marginalized identities. We conducted an interpretive qualitative study examining how summer geoscience field programs affected two undergraduate, marginalized students' self-efficacy. Adding to existing theoretical explanations of self-efficacy, we identified three types of self-efficacy impacted positively and negatively by geoscience field experiences: academic, physical, and social self-efficacy. We developed a nuanced understanding of the specific field experiences that influenced the 'ups and downs' of students' self-efficacy and, ultimately, their intent in continuing to pursue a geoscience education or career. Despite negative experiences, including gender discrimination, crude sexual jokes, and a lack of belonging, the students described their intent to persist in geoscience. Our findings can assist geoscience educators (and others in field-based sciences) to consider experiences that support and hinder marginalized students' self-efficacy. Also, our findings can guide efforts to improve geoscience field programs to create more inclusive environments.

Introduction

For over 40 years, diversity in geoscience remains one of the lowest across all science, technology, engineering, and mathematics (STEM) fields, despite modest gains (Sidder, 2017; Bernard & Cooperdock, 2018). Calls for addressing diversity in geoscience have acknowledged these equity gaps (Baber et al., 2010; Gates et al., 2019; Núñez et al., 2020, 2021). Now, more work is being done to recruit and retain diverse students in the discipline (Baber et al., 2010; Pugh et al., 2019) and provide an inclusive environment (Atchison et al., 2019). Even the discourse is beginning to change. For example, Fairchild et al. (2022) examine the discourse during geology field experiences, finding that although the dominant narratives are masculine, an inclusive discourse is emerging to challenge the archaic social norms of the discipline. Yet, despite increasing awareness, work is needed to bridge the remaining equity gaps. In our study, we focus on experiences students with historically marginalized identities (specifically, gender and sexuality) have in these geology field camps to determine how those experiences may

impact student's self-efficacy and, ultimately, their interest in pursuing the discipline.

Literature review

Benefits and barriers of undergraduate geoscience field experiences

Undergraduate field experiences are an essential part of U.S. undergraduate geoscience programs (Petcovic et al., 2014). Traditional field experiences occur in outdoor settings in areas that highlight important geologic features and can range from a few hours to multiple weeks. Geoscience field experiences provide many benefits to geoscience students. The experiences are perceived as valuable opportunities to increase students' geoscience knowledge and skills (Boyle et al., 2007; Fuller, 2006; Núñez et al., 2021; O'Connell et al., 2021; Petcovic et al., 2014; Schiappa & Smith, 2019; Stokes et al., 2011). Elkins and Elkins (2007) confirmed geoscience knowledge gains through pre and post knowledge testing. Students and faculty also report that geoscience field

experiences enhance students' affective domain elements (for a review of the affective domain, see Van der Hoeven Kraft et al., 2011). For example, students' geoscience interest, identity, self-efficacy, and enjoyment are perceived to increase during field experiences (Boyle et al., 2007; Kortz et al., 2020; Petcovic et al., 2014; Schiappa & Smith, 2019). Students' anxiety about doing field work is perceived to decrease after engaging in field experiences (Boyle et al., 2007). During field experiences, students often work in groups and even if they work individually, students are still immersed in a 'community of practice' focused on investigating a common problem (Mogk & Goodwin, 2012). Students report that the peer interactions during field experiences increase their sense of belonging to other students in the field program, sense of belonging to the geoscience discipline, enjoyment working with peers, and confidence in working in a group (Atchison et al., 2019; Boyle et al., 2007; Fuller, 2006, Posselt, 2020; Posselt & Nuñez, 2022; Schiappa & Smith, 2019). Another benefit of field experiences is that they support and even increase students' intentions to pursue a geoscience major and career (Kortz et al., 2020; Schiappa & Smith, 2019).

As described, field experiences may improve or or diminish students' affective domain characteristics. For example, field experiences can decrease students' geoscience interest, identity, and self-efficacy (Kortz et al., 2020; Petcovic et al., 2014), or they may decrease students' intentions to pursue a geoscience major and career (Kortz et al., 2020). These negative feelings may be most likely to emerge for students with marginalized identities. For example, for female students, field experiences can be an exclusionary social climate (Posselt & Núñez, 2022) where they are more likely to be "ignored, dismissed, or receive minimal response" (Posselt, 2020, p. 42). Women also encounter sexual assault, harassment, and discrimination during field experiences (Clancy et al., 2014; Giles et al., 2020; Maguire, 1998; Sexton et al., 2020). Additionally, field experiences are perceived to present barriers for students with disabilities. This occurs in ways such that those students may not be able to participate in the experiences at all, and if they do participate, may have limitations on their participation and learning (Atchison & Libarkin, 2016; Hall et al., 2002; Mol & Atchison, 2019; Núñez et al., 2021).

Role of self-efficacy in learning and academic and career selection

According to Bandura (1997), self-efficacy is defined as "the exercise of human agency through people's beliefs in their capabilities to produce desired effects by their actions," (p. vii). Studies pertaining to the affective domain suggest self-efficacy may be a meaningful way to understand individuals' various academic or career pursuits (Pugh et al., 2021) such that higher levels of self-efficacy may increase one's likelihood of persisting in a certain discipline (Kelsey, 2007; Mohr, 2018). Alternatively, challenges to one's self-efficacy due to sexism (Deemer et al., 2014; Kelsey, 2007), stereotype threat (Parson et al., 2021), or low social

belongingness (Tellhed et al., 2017) may negatively impact one's likelihood of pursuing certain disciplines. It is important to note, however, that decreased self-efficacy may not lead to a decreased likelihood of pursuing a discipline (Deemer et al., 2014), or vice versa, which may be accounted for by factors that influence student persistence, such as high levels of interest or identity with a discipline (Kortz et al., 2020) and a sense of belonging (Rainey et al., 2018).

Bandura (1997) proposed four sources of self-efficacy (mastery experiences, vicarious learning experiences, social persuasion, and physiological state) that scholars have used to understand how individuals constructs their self-efficacy beliefs (e.g., Kortz et al., 2020; Trujillo & Tanner, 2014; Zeldin et al., 2008). Mastery experience refers to how one's past performance may either create a strong sense of self-efficacy, if the task was well-accomplished, or lower one's self-efficacy, if failure was related to the task, especially if the failure happened early or repeatedly (Zeldin et al., 2008). According to Bandura (1997), of the four sources, mastery experience is most critical to one's self-efficacy, though studies suggest this may not always be the case for women in male-dominated disciplines, such as STEM (Zeldin & Pajares, 2000). Secondly, vicarious learning experiences may help one develop strong self-efficacy when they observe successes of others, especially others similar to the observer, or lower one's self-efficacy when one observes the failure of others (Zeldin et al., 2008). Vicarious experiences have been identified as an important source of self-efficacy for women in mathematics-related careers (Zeldin & Pajares, 2000). Thirdly, social persuasions are "messages from others about one's ability to accomplish a task," (Zeldin et al., 2008, p. 1037). Encouraging messages may positively impact one's self-efficacy, whereas messages undermining one's abilities may have a negative impact. Sexism, racism, heterosexism, and other forms of discrimination, stereotypes, or biases are examples of societal messages that may impact one's self-efficacy. For example, societal messages (e.g., images and discourse) suggesting that women do not fit the traditional image of a scientist, may result in women's lower self-efficacy to pursue STEM careers (Tellhed et al., 2017). This pattern is true for individuals of all other historically marginalized identities as well. Lastly, physiological state is used to explain how certain emotions may differ across individuals. For example, where one may have a positive emotional response to anxiety (energizing), others may find it debilitating (Zeldin et al., 2008). Each of these four sources of self-efficacy help our understanding of factors that may impact the self-efficacy of students in geoscience.

Geoscience field experiences have been found to foster or reduce student self-efficacy, which may be a factor contributing to retention in the discipline (Baber et al., 2010; Boyle et al., 2007; Kortz et al., 2020; Schiappa & Smith, 2019). We add to existing literature by conducting a qualitative study to trace the self-efficacy experiences of two students in geology field programs. We seek to understand how contextual experiences during camp impact the self-efficacy of marginalized students and whether those experiences influence students' academic and career plans in geoscience.

Research question

We trace marginalized students' self-efficacy experiences with the following guiding research questions: How do contextual experiences occurring during a multi-week undergraduate geoscience field program impact marginalized students' self-efficacy? How do these self-efficacy impacts influence marginalized students' academic and career plans?

Methods

We used an interpretive qualitative research design to understand the experiences of marginalized students in geology field programs. An interpretive qualitative research design (also referred to as a basic qualitative design, basic interpretive design, or generic design, Merriam & Tisdell, 2016), like all qualitative research, aims to uncover and interpret individuals' experiences (Merriam & Tisdell, 2016). Examples of social science studies that used an interpretive qualitative research design are provided by Merriam (2002) and Merriam and Grenier (2019). Examples of geoscience education research studies using an interpretive qualitative research design were conducted by Sexton (2012) and Sexton et al. (2020).

An interpretive qualitative research design is the most common qualitative design in education research (Merriam & Tisdell, 2016). It is the most common perhaps because it is very flexible, allowing for a wide range of topics to be investigated, theoretical frameworks to be used, and qualitative data collection and analysis methods to be implemented (Merriam & Tisdell, 2016). Other qualitative research designs have additional purposes, philosophical lenses, and methodological elements beyond those of an interpretive qualitative research design (for descriptions of other research designs see Creswell & Poth, 2016; Flick, ed., 2022; Merriam & Tisdell, 2016; Patton, 2014). For example, a grounded theory research design "seeks not just to understand, but to also build a substantive theory about the phenomenon of interest" (p. 24, Merriam & Tisdell, 2016). A grounded theory design also includes methodologies like theoretical sampling and constant comparative analysis (Merriam & Tisdell, 2016; Strauss & Corbin, 1998). A case study design may also have been appropriate for our study. However, according to Merriam and Tisdell (2016), "it is the unit of analysis that determines whether a study is a case study" (p. 39) and not the "topic of investigation" (p. 38). Further,

Merriam and Tisdell argue that the defining characteristic of case studies is their focus on investigating bounded systems. We ultimately selected an interpretive qualitative research design because the topic of our investigation (contextual factors of field programs that influence self-efficacy experiences) is as important as our focus on marginalized students. We also selected an interpretive qualitative research design due to its flexibility with theory and methods and because the "additional dimensions" (Merriam & Tisdell, 2016, p. 24) (i.e., theoretical frameworks and methodological elements) of other designs were not necessary to answer our research questions. An interpretive research design enabled us to incorporate self-efficacy theory (described in the literature review section) and critical theory (described in the trustworthiness section). As part of the design, we conducted individual interviews to identify students' self-efficacy experiences and used the coding approach described by Miles et al. (2020) to analyze our data.

Sites and participants

In a larger study focused on understanding students' overall experiences in geoscience field programs, we collected data from three U.S. geoscience field programs with long track records of undergraduate field education. Field program names are confidential to protect the privacy of participants. Each site enrolled 30 to 40 students and employed four to six faculty instructors and teaching assistants. All programs occur in the Western U.S.

In that larger study, we administered a pre-survey, post-survey, and 12-month follow-up survey to examine a range of constructs (Table 1). We also conducted a post-program interview (occurring no later than eight weeks after the field program ended) and a 12-month follow-up interview (occurring a year after the program ended). Thirteen students completed all three surveys and both interviews. We were interested in understanding the self-efficacy experiences of marginalized students. We were particularly interested in the experiences of marginalized students who also perceived encountering a hostile social climate during the field program. We used critical case sampling (Patton, 2014) to identify students. The critical case selection criteria included: 1) member of marginalized gender or sexual orientation identity (identified from pre-survey data) and 2) marginalized students who reported experiencing the most hostile social climate and gender discrimination compared to other marginalized students

Table 1. Survey constructs and scales collected in the larger study and those used in the current study.

Construct/Scale	Pretest[a]	Posttest[b]	12-month Follow-up Test[c]
Personal factors: Interest in Geoscience, Self-Efficacy in Geoscience[d], Transformative Experience (all scales from Pugh et al., 2019)	x	x	
Contextual constructs: Gender Discrimination Experienced[d], Social Climate[d], Program Structure		x	
Academic/Career Paths Questions: Confidence in Continuing in Geoscience Major[d], Intent to Pursue Geoscience Career[d] (Pugh et al., 2019)	x	x	x
Demographic Information: Gender Identity[d], Sexual Orientation[d], Race/Ethnicity, and so on	x	x	

[a]Pretest administered two weeks before the start of the field program.
[b]Posttest administered 4-6 wk after conclusion of the field program.
[c]Follow-up test administered 12 months after conclusion of the field program.
[d]Construct/scale used in current study as selection criteria or as data.

(identified from post-survey data). Choosing these criteria for the critical cases provide insight into how field programs influence the self-efficacy and academic and career choices of students from marginalized identities. We strongly believe, as suggested by hooks (1984), that understanding the experiences of those at the margins will provide insights on how to provide a more inclusive and equitable environment that will support everyone, including those whose experiences are often centered. Student demographic information and other characteristics are reported later in the paper when describing the cases. Pseudonyms are used to protect the confidentiality of our participants.

To identify students who reported the most hostile social climate and gender discrimination, we used the summed scores for two scales on the post-survey. We used a gender discrimination and social climate scale (Clancy et al., 2014), both of which use a five-point Likert Scale from strongly disagree (scored as 1) to strongly agree (scored as 5). A higher gender discrimination score indicated the student reported experiencing higher levels of gender discrimination. A lower social climate score indicated a student reported experiencing a more hostile social climate. Of the 13 students for whom we had a full dataset, five identified as women and three identified as gay, transgender, queer, lesbian, or asexual. The two marginalized students who reported the most hostile social climate and gender discrimination were a woman who identified as heterosexual and a man who identified as gay. These students are the focus of our analysis.

Data

For the larger study, we collected survey data and conducted interviews with students to explore their experiences in geoscience field programs. The survey data were used in this current study to identify the two critical cases. The survey data were not used in analysis. To answer our research questions for this aspect of the larger study, we used the interviews developed for the larger study. Examples of interview topics and questions include those related to students' academic and career plans (e.g., In the survey, you mentioned that your academic/career plan is [describe plan]. Is that still your plan or has it changed?); negative experiences encountered (e.g., As you look back on your field program, what negative experience most stands out in your mind or was most memorable?); and the impact of those experiences on interest and self-efficacy (e.g., How did the

experience[s] you shared affect your interest and confidence in geoscience as a major?). A complete list of interview questions is available in this article's supplemental material. We conducted two interviews: a 60- to 90- minute post interview that occurred six to eight weeks after the end of the field program and a 60- to 90- minute interview that occurred 12 months after the end of the field program. The two interviews were transcribed verbatim. The two interviews explored a range of topics as part of the larger study including topics relevant for this study: how self-efficacy and academic and career choices were impacted by field programs. There were specific questions about self-efficacy and academic and career choices in the interview; however, during analysis we found that students described their self-efficacy and academic and career choices throughout the interviews. Therefore, the entire interview transcript for both interviews were included in analysis.

Data analysis

We used Concept Coding, Descriptive Coding, and Magnitude Coding to explore participants' self-efficacy experiences. Figure 1 shows an overview of the three types of coding. First, we used Concept Coding (Miles et al., 2020) to identify self-efficacy narratives or stories provided by participants across their two interviews. Concept Coding is used when researchers aim to assign an idea or concept to represent the meaning of experiences or stories told by participants (Miles et al., 2020). In our study, self-efficacy was the concept and we used Bandura's definition of self-efficacy—"people's beliefs in their capabilities to produce desired effects by their actions" (1997, p. vii)—as the definition of the Self-Efficacy Concept Code. Therefore, the initial coding of text into the Self-efficacy Concept Code was deductive coding (Miles et al., 2020) as we used an existing definition for self-efficacy. We included participant stories that described self-efficacy experiences based on any of the four sources of self-efficacy described by Bandura (1997). Three categories of self-efficacy that field programs affect emerged inductively (Miles et al., 2020) from the data coded into the Self-Efficacy Concept Code: *Academic, Social, and Physical. Academic self-efficacy* is related to one's ability to perform the academic and career-related tasks during field camp. *Physical self-efficacy* is related to one's ability to perform physical tasks during field camp. *Social self-efficacy* is related to one's ability to interact with other individuals in the camp setting. We recognize some self-efficacy
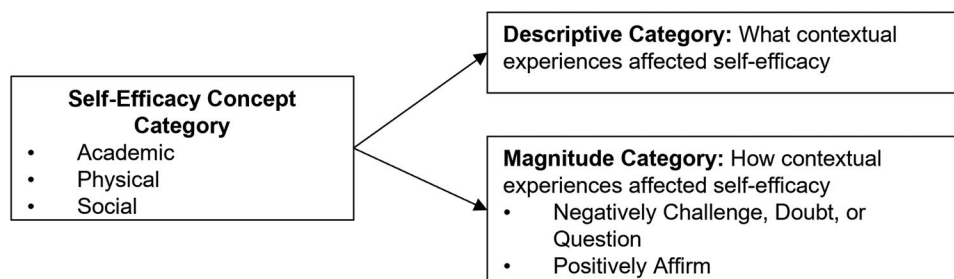
Figure 1. Model depicting the coding categories and process for differentiating participants' stories about self-efficacy during field camp.

experiences fit into more than one self-efficacy category. For example, some academic tasks during field camp have a physical component (e.g., mapping requires walking) and/or a social component (e.g., group work). Despite this overlap, we coded according to the category that was most salient in the content described by participants. For example, a discussion of group work dynamics which focuses more on the social interaction with group members than the assignments they are working on, would be coded as *Social self-efficacy*.

After identifying Self-Efficacy Concept Categories, we used Descriptive Coding (Miles et al., 2020) to code what contextual experiences affected students' self-efficacy. For example, an experience in which a participant reported that they doubted their academic abilities because a male student made disparaging comments about women would be assigned a descriptive category of "male student made disparaging comments about women." There were many Descriptive Categories as they were intended to summarize the contextual experiences in each of the stories coded into the Self-efficacy Concept Categories. We used Magnitude Coding (Miles et al., 2020) to code how self-efficacy was affected in each experience coded into the Self-Efficacy Concept Categories. In some cases, an experience led a participant to negatively challenge, doubt, or question their self-efficacy. In other cases, an experience led a participant to positively affirm their self-efficacy. Therefore, we created two magnitude categories: Negatively challenge, Doubt, or Question and Positively Affirm.

Our final analysis was to examine how students' academic and career choices were affected. In both interviews with participants, we explicitly asked them to describe their academic and career plans. We used participants' responses to those questions in our analysis. We also reviewed the entire interview with participants to identify any other comments in which participants described their academic and career plans. We used Magnitude Coding (Miles et al., 2020) to categorize participants' academic and career plans. There was one category: *Continuing*. Both participants described continuing on in their geoscience academic and career paths.

We used a team-based approach to coding. MacQueen et al. (2008) recommends that one team member serve as the lead analyst during team-based research, and Fairchild served in that role. Fairchild conducted the initial coding. Sexton and Newman conducted peer reviews of the coding. Using guidelines by Merriam and Tisdell (2016), Fairchild, Sexton, and Newman discussed the coding and used consensus agreement to determine changes to the coding. Fairchild made changes to the coding based on the discussions and consensus agreement. McKay, Hinerman, and Riggs provided an additional peer review of a sample of data, codes, and findings. They agreed with the coding and findings and found no aspects that required changes.

Trustworthiness

Following recommendations from Merriam and Tisdell (2016), we incorporated several strategies to address trustworthiness. We describe our researcher perspectives and identities to highlight the lenses we bring to the study. We approached this study with a critical research perspective (Merriam & Tisdell, 2016). Critical theory suggests that context and systems (e.g., university, program, course, and social systems) primarily support majority identity students. Therefore, we see it as vital that we study the experiences of marginalized students to understand how context and systems do or do not support marginalized students and how systems need to be disrupted to better support marginalized students. Because of our critical theory lens, we examined the context in geology field programs to understand students' self-efficacy experiences.

Critical theory also recognizes that researchers operate a range of insider and outsider statuses based on their identities and power within society; therefore, we share our identities to highlight our positionality. We are all from the United States. Four members of our team identify as women and four of us identify as white. All of us identify as cisgender and heterosexual. Fairchild and Newman are sociologists, Sexton, McKay, and Riggs are geoscience education researchers, and Hinerman is an education researcher. Only Sexton, McKay, and Riggs have been students and/or instructors in geoscience field settings, though Hinerman has engaged in field archeology settings.

Results

For each participant we describe their self-efficacy experiences, their overall impressions of camp, and how their experiences impacted their academic and career decisions. The first participant is Hannah and the second is Ryan.

Hannah

Self-efficacy experience

Hannah is a white, heterosexual, cisgender, female undergraduate student majoring in geology. In our analysis of Hannah's experiences through field camp, we find 18 instances that may have had an impact on her self-efficacy. Seven of these experiences may have led her to positively affirm her self-efficacy, whereas 11 led her to question or doubt her self-efficacy (Table 2). All the affirming self-efficacy experiences were related to her academic abilities, whereas experiences causing her to question or doubt her self-efficacy spanned all categories of academic, social, and physical abilities. In the following section, we trace her self-efficacy experiences related to field camp.

Academic

From our analysis, we identify 14 experiences described by Hannah as impacting her *academic* self-efficacy. Seven experiences led Hannah to positively affirm her self-efficacy, and seven experiences led her to doubt and/or question her self-efficacy.

Table 2. Example experiences impacting Hannah's academic, social, and physical self-efficacy.

Self-Efficacy Categories	Impact on Self-Efficacy	Experiences
Academic ability	Negatively Challenge, Doubt, or Question	Anticipation that knowledge/skills are less than what is needed to be successful at field camp
		Ignored by group members
		Male students questioned participant's abilities
		Male students made disparaging comments about women
		Students acting superior toward her and other students
		Heard stereotypes of women
		COVID impact on job prospects
	Positively Affirm	Defying societal perceptions of women in geosciences
		Group work accomplishments by learning to trust her own knowledge
		Achieved higher scores on fieldwork assignments than peers
		Achieved higher scores on exams than peers
		Received higher scores despite male students making disparaging comments about women
		Support from TA
		Completion of the field camp overall
Social ability	Negatively Challenge, Doubt, or Question	Faculty favored other students over her
		Heard stereotypes of women
Physical ability	Negatively Challenge, Doubt, or Question	Hiked more slowly than other students
		Students acting superior toward her and other students

Prior to camp, Hannah was concerned about her academic preparation, which led her to doubt her academic skills. She says,

> I did all my classes out of order, so I [felt like] I'm not going to know anything in the order I was supposed to. I was really hoping to… be ready for [field camp], but I was like 'I'm not going to know anything.'

However, after arriving at camp, we find that she started to feel validated in her abilities through certain group work experiences. She describes how students in her work groups, "helped me learn more about myself. I feel like…I learned to stick with my gut and what I know." These affirmations of self-efficacy helped Hannah realize she did have the necessary knowledge to be successful at camp.

Some of the group dynamics mentioned above affirmed Hannah's abilities, but other experiences may have negatively challenged Hannah's academic self-efficacy. For example, stereotypes of women and their abilities in the field were reasons Hannah questioned her academic abilities, as she explains,

> One male [student] always believed that I wouldn't be able to give the right information to complete the project. And he always felt that he would be smarter than me and that I wouldn't know as much…I felt like he was like, oh, you're a female, and you don't know as much as I do.

Students rode in vans to the various field sites, which is where Hannah describes these negative experiences occurring. She says,

> I ended up with a lot of guys in the van all the time. And so, [they] still don't think very highly of women in a sense. They just thought that women existed…they don't believe that women should even be here…They made it seem like we shouldn't be out in the field. That we shouldn't be out hitting rocks. We shouldn't be playing in the dirt. We should be at home, or like the saying of, 'women belong in the kitchen,' or something like that.

This comment suggests that Hannah perceived these individuals as sexist and as holding stereotypical beliefs about the social roles of women, thus making a negative impression on her. However, her academic self-efficacy may have boosted when she realized she was just as capable, if not more capable, than her male peer. She tells us,

> He obviously thinks that [women aren't] as smart, or some of these guys don't think we're as smart or as capable as they are, but yet again, we're still there. And we're still getting grades as good, if not better, than them.

Therefore, although the sexist comments and treatment by her male peers may have led her to question her academic self-efficacy, her performance on assignments and exams affirmed her self-efficacy after realizing she scored higher than her male peers.

After field camp, Hannah confirmed her interest in continuing to pursue graduate education and a career in geoscience despite experiencing experiences that served to challenge her self-efficacy in attaining advanced education and a career in this discipline. She highlights her sense of accomplishment with completing the field program and describes how she was one of few students who decided to pursue a career in geoscience fieldwork at her university in recent years, saying,

> I was the only one [of three geoscience undergraduate majors who graduated at the same time] who went and did field camp and I was the only one that was able to actually go and continue my education… and I think that was the most positive experience that I could get out of it was knowing that I was furthering my education when others really didn't want to or didn't choose to and knowing that even with the class that graduated prior to me, of the ones that went on to grad school, there was only one other one that went and continued their education at a field camp. And so, it felt like I was able to complete something that not everybody was able to complete.

This sense of accomplishment despite challenges to her self-efficacy may have helped Hannah view the entire field camp experience positively. She describes her internal monologue, saying, "The whole experience in and of itself was like, 'okay, you do know your stuff. You know what you're

doing. And now you're able to do it.'" Overall, these examples demonstrate the highs and lows of Hannah's academic self-efficacy experience and the undue challenges that women in these male-dominated spaces may be forced to overcome to continue on a career path they have long been passionate about. These experiences raise questions about the kinds of challenges to women's academic experiences in the field that may deter some women from continuing to pursue a field where they are constantly faced with the narrative that they do not belong or are not capable in this space due to their gender.

Social

Our analysis identified two experiences that Hannah had with individuals at field camp that led her to doubt or question her social self-efficacy. After hearing male students make sexual comments objectifying women, or as she describes it, "locker room talk," she says she felt the need to "tread water slowly" with the male peers in her camp. She says, "Okay, this is what you think about women?… It made me uncomfortable for a couple of the conversations that got really personal, like the breast one [men discussing women's breast sizes]. It's like, okay, well, I'm sitting here!" Hannah's reflection tells us how these conversations made her feel uncomfortable and awkward in her interactions with her male peers. This finding suggests how sexual comments may impact the self-efficacy of female students (or students with other marginalized identities) who may feel singled out by comments like these.

An experience related to faculty interactions during camp may have also challenged Hannah's social self-efficacy. She tells us how she experienced difficulty with a male student and was paired with the same student several times. She wanted help from the field camp faculty, but felt she could not approach them because they favored certain students over others:

> I think there was some favoritism for [some of] the students, but I don't think it was favoritism to the extent where they would alter grades or anything like that. I think it was favoritism of, oh, this person can keep up on the hikes and this person can be at the front of the pack and this person looks like they can do everything on their own. But this [other] person's struggling to keep up hiking and this person's maybe doing the project a half an hour slower than the other, so maybe they're not as great….[The faculty] kind of stuck with the ones that they thought were the better ones or the ones that they thought were gonna do the best on the projects or always hiked the fastest or always kind of the more social ones…And so, I always felt like, oh, they're already having that favoritism towards them…So I think that was the biggest, I don't know, that kind of drew me away from certain faculty in a sense. That they automatically kept going back to the same groups of people and hanging out with the same groups of people and kept checking on the same groups of people, but leaving out, well, other ones.

This quote highlights how Hannah's social self-efficacy may have been affected as she felt unable to have faculty intervene with the negative and sexist interactions she was experiencing from her male peers. Moreover, these feelings of exclusion from the faculty's preferential

student group, may have contributed to lower levels of self-efficacy.

After completing field camp, we find from Hannah's story that her social self-efficacy may have been affected while seeking a career or additional education in geoscience. When asked how sexual jokes and locker room talk impacted her, Hannah says she does not think she was impacted negatively because she still intends to pursue a future in geoscience. However, the challenge to her social self-efficacy is suggested when she says, "I'm willing to work with anybody, but I always know that there is that possibility that they are talking like that behind closed doors." This quote suggests how she may internalize the perceived sexism during camp such that she questions how she thinks others perceive her abilities. In fact, Hannah draws parallels between the sexist comments she perceived in field camp and a more recent job interview, saying,

> I could tell that the men that I interviewed with, kind of felt the same way as that student [who made sexist comments]…It was kind of one of those things where it's like, oh, they think that I'm not gonna be able to do this job either, kind of sense. I didn't get that job either, but it kind of gave me the sense that they didn't feel I was capable in a sense, just like the student did.

This negative social self-efficacy due to this perceived sexism may be of concern for the retention of all women (and other individuals with historically marginalized identities) in geoscience, especially those who may not have persisted in the discipline for as long as Hannah.

Physical

We identified two experiences challenging Hannah's physical self-efficacy. The first experience relates to Hannah's hiking abilities. She and another student were not as fast as their peers. In describing her and her peer's experience she says,

> We kind of were slower hikers…so the groups would leave us behind a lot…But I can't catch up because I'm moving as fast as I can and I don't want to get sick and stuff like that. So I always felt bad that [her peer] is kind of in the same boat as I am and struggling with the same things [in terms of hiking ability]. And there's nothing we can really do about it or say about it to change it up at all.

This statement demonstrates how her perception of her slow hiking speed may have challenged her physical self-efficacy as a geoscientist due to her struggles in keeping pace with other students. Similarly, we find that Hannah describes fast hiking male students acting superior to the slower hikers because of their physical ability. She explains,

> I had such a bad experience with more of the males than I did with the females. They always thought they were better in a sense…I guess maybe cocky is the best way to put it, but that they were better than us women and they thought they could really succeed or do well in the program.

She mentions this discourse occurring across a "handful" of the men, but also happening within a group of women at camp as well. When asked about the characteristics of these students, Hannah is quick to point out how they

"seemed to be a little more athletic" than other students (like herself) in the camp. These examples suggest the ways in which Hannah's physical self-efficacy was challenged during her field camp experience. Despite Hannah having the necessary physical requirements to complete the tasks, we find that she may have doubted her physical self-efficacy because she felt she could not keep up with her peers.

Overall impression

Although Hannah experienced multiple challenges to her academic, social, and physical self-efficacy, her overall impression of field camp is positive and she describes it as an experience that supported her personal growth. In fact, overcoming challenges to her self-efficacy may have improved Hannah's sense of resilience in pushing through various negative interactions. She says, "Overall, field camp was a really good experience because it taught me that I can believe in myself before believing in others" and to "stick with your gut and go with it." Her response illustrates that she persevered and feels that she is better able to trust her instincts and knowledge, even when others do not trust her abilities. In her second interview (one year after camp), Hannah says,

> It was a good experience in the sense that even though a lot of things were pretty hard and not always positive, overall, [it was] a learning experience and [the] overall gaining of the network through socialization was a positive thing.

In sum, we find that Hannah describes several challenges to her academic, social, and physical self-efficacy throughout field camp. We also find that Hannah describes benefiting from the field camp experience, yet this mix of findings suggest that Hannah may have needed to dig deeper than other students (especially those with dominant identities) to persevere through these negative, hostile experiences and learn to trust her abilities without external support.

Impact on academic or career path

In the pre-survey, Hannah identified her academic plan was to pursue a Master's degree in geology. In the follow-up survey and follow-up interview, she revealed that she had not changed her decision. However, we find that she was encountering challenges with faculty at her undergraduate university not helping her on the job market. She says,

> I still wanna go get my Master's, but everything between my faculty at my university, not helping me out a lot has left me kind of sitting where I'm just job searching and trying to figure out how to get a Master's and do a Master's completely on my own. So it's kind of been put on hold a bit, but I'm still looking to do that eventually.

Some of this lack of support likely resulted from challenges of COVID-19. Nonetheless, the impact of her experiences in field camp served to reinforce her interest in geoscience and helped narrow her area of interest for her Master's degree. She says that field camp,

> Definitely made me wanna stay in the geoscience field. I really did enjoy the fieldwork and I really did enjoy the projects that went along with it. So, I think that helped confirm that I wanted to do something in that geology field…It put me more in the sense of doing a major or a Master's in geology rather than just like soil science or just a science Master's.

Hannah mentioned in her pre-survey that she was interested in pursuing a career in geology after she completed her Master's degree, but she was not sure exactly what industry she would choose. In her follow-up survey and interview, Hannah described that she still intends to work in a geology-related field and has now narrowed her interests into five main disciplines that interest her the most, all of which are areas of specialization within geology. She says, "I definitely narrowed it down to be like, I know I kind of want something in this kind of area." As far as a specific career path, Hannah has remained open to a variety of industries that employ geologists.

This analysis of Hannah's story highlights several "ups and downs" in her self-efficacy experience during field camp. We find that Hannah still plans to continue her academic and career path in geoscience, but that does not make her negative experiences any less problematic. It is possible that her deep interest in geoscience may have minimized some of the negative experiences at field camp that challenged or caused her to doubt her academic, social, or physical self-efficacy. That said, it is worth noting the additional emotional and psychological labor required of Hannah to overcome these challenges to her self-efficacy encountered during field camp to persist in geoscience. Many other students, particularly those with dominant identities, may not require this kind of additional emotional labor in order to feel competent and confident in the discipline.

Ryan

Self-efficacy experience

Ryan is a white, gay, cisgender male undergraduate student majoring in geology. From our analysis, we identify five experiences that positively affirmed Ryan's self-efficacy and eight that may have led him to doubt or question his self-efficacy (Table 3).

Academic

We identify four experiences related to Ryan's academic abilities, three which helped positively affirm and one that challenged his academic self-efficacy. Prior to the start of field camp, Ryan describes concern about his academic preparation, causing him to doubt his self-efficacy. He says, "I was nervous academically, like, 'am I good enough to actually succeed in this class?'" These concerns manifested during camp when he experienced challenges to his academic self-efficacy. For example, he says,

> I really didn't get a chance to enjoy myself there. I kind of had PTSD when I had to go back to the same field area that I struggled with prior. And I was like, man, I wish I could just

Table 3. Example experiences impacting Ryan's academic, social, and physical self-efficacy.

Self-Efficacy Categories	Impact on Self-Efficacy	Experiences
Academic ability	Negatively Challenge, Doubt, or Question	Anticipation that knowledge/skills are less than what is needed to be successful at field camp.
	Positively Affirm	TAs unprofessional & not knowledgeable about program material
		Faculty support during camp
		Perception of assignments, fieldwork, and his performance at camp overall
Social ability	Negatively Challenge, Doubt, or Question	Unprofessional behavior from TAs
		Working student job at field camp
		Group work activities
		Sexist heteronormative talk at field camp
		Living in all-male cabin
	Positively Affirm	Group work activities
Physical ability	Negatively Challenge, Doubt, or Question	Working student job while at field camp
	Positively Affirm	Athletic abilities during group work activities

be here and enjoy myself. Instead, I'm just constantly stressed about the assignments.

Though this constant struggle with his academic self-efficacy was due, in large part, to the exhaustion from working a student job, he still describes how this managed to impact his own perception of his ability to perform certain tasks, especially after struggling with them initially.

Aside from experiences which may have caused Ryan to doubt or challenge his academic self-efficacy, he also experienced several experiences that may have affirmed his self-efficacy. Ryan felt the teaching assistants (TAs) were unprofessional and unknowledgable about the material being taught. Yet we find that their lack of knowledge may have helped to affirm his competence; he explained,

> [The TAs] were not very good at all. I was appalled because they didn't seem to have reviewed any of the material before coming [to camp], and so I felt smarter than a lot of them, and I had to correct them on a couple of occasions.

Ryan's disappointment in the TAs may have served to affirm his abilities, making him want to become a TA and "do better," than he felt they did at camp. He says, "Honestly, I want to be a TA there now, just so I can do better than them. I asked them a lot of questions and they just didn't know the answer or would defer to the camp director." This experience suggests affirmations to Ryan's academic self-efficacy, which were reinforced through his perception of the assignments at camp and camp experience overall. He says,

> There's a lot of positive experiences [from camp]. I think maybe academically finishing one of the maps, one of the really long-term projects over a very wide scale, finishing that mapping project was really satisfying and doing well on it. And then, just the whole experience itself, looking back on that like, 'Wow, I really did that.' There were a lot of little moments like that where I was just proud of myself for being able to do it–reaching geological goals, in a way.

Later he continues, "I feel like [field camp] improved my confidence, for sure. In some ways I wasn't really sure what fieldwork entailed, exactly. I kind of expected it to be more difficult." He goes on to say how he felt confident enough in his fieldwork skills during camp to help other students. Ryan also reflects positively on the faculty at camp and how they positively affirmed his academic self-efficacy, saying,

"They were very much role models for me and still are. Like, what I could be one day, if I work as hard as them. And so, I still think of them fondly and how helpful they were." This highlights the positive impact that faculty have on the students in camp, by helping students see themselves in their role models, which may be especially important for students with underrepresented and historically marginalized identities.

Social

We found Ryan describing one experience which positively affirmed and five that negatively challenged his social self-efficacy. Ryan's interactions with the TAs at camp is an experience that may have challenged his social self-efficacy. After a misunderstanding occurred between Ryan and a couple TAs, he no longer felt comfortable interacting with them, saying he felt "Kind of very separate from the TAs…I felt like I couldn't really talk to them afterwards, in any sort of social manner." Later in the interview, he adds,

> The TAs were very much on a power trip, it seemed, where they felt like they were kind of in charge of you and they weren't easy to talk to. And I felt like I couldn't ask them questions if I wanted to, or correct them if I saw they were wrong because they would have been offended…During the camp, it just seemed like [the TAs] were purposely trying to harden you and be like, 'Oh, I went through this, and it's really hard, isn't it? And it sucks, doesn't it?'

This example suggests how negative interactions with the TAs served to challenge Ryan's social self-efficacy by making it more challenging for him to form connections and positively engage with them.

Related to the relationships Ryan was forming with other students at camp, he mentions the challenge of being a gay male at the field camp. He says,

> It didn't really affect, so much as bother me. I was a gay guy. And so that was kind of hard. It was just kind of annoying because I didn't really want to talk about the things they were talking about.

The "things they were talking about" Ryan references were the sexual talk from male students in the cabins. He says,

> A lot of times they would talk about very sexual things at night, which was very annoying. I just wanted to go to sleep and I would be over hearing these discussions about different kinks

and stuff. I definitely was not a fan, which kind of made me an outcast in a way.

Ryan's social self-efficacy is challenged here due to the lack of belonging he feels unless he participates in sexist talk, a challenge that may be felt by other students who do not wish to participate in this type of talk.

We find that in response to negative experiences, Ryan is forced to negotiate by finding ways to be in situations and learn, in spite of what is happening. He also describes situations that may have affirmed his social self-efficacy through the group work activities at camp. He was able to take on a leadership role, pushing his group members to complete the tasks. Although some students may have felt he was a bit 'too much,' he was driven to help his group succeed. He says,

> I was kind of hated in a lot of my groups because I would be the impromptu leader. I felt kind of bad about that, but no one else would take the reins, or make decisions. And so, I kind of had to sometimes, and a lot of times they didn't want to do anything and I was like, 'No, we still have a lot of things to do.'

He adds later, when asked how he felt about taking on that role as a leader, "It kind of was nice because I had been in leadership roles in the past, so I was like, 'Wow, I feel like I can be a good leader on occasion.'" Despite Ryan being forced to negotiate the experiences negatively impacting his social self-efficacy, he describes feeling affirmed in his social self-efficacy after rising to a leadership role in his peer groups.

Physical

Ryan encountered experiences that challenged and reinforced his physical self-efficacy. Ryan describes his exhaustion playing a large (negative) role in his camp experience. He says, "It led me to feel more exhausted than other people, I believe" and "I felt like I was never working at my highest potential and I remember being a little miserable sometimes…If you don't get enough sleep, it's difficult to perform at your best." Since field camp work involves both physical and academic components through fieldwork, this quote also suggests how exhaustion affected Ryan's physical self-efficacy. However, despite this physical challenge, Ryan's description suggests him feeling affirmed in his physical self-efficacy due to his athletic abilities during group work activities. He says, "I'm pretty athletic, so I always did well in the field and didn't have any physical problems." Overall, Ryan experienced both challenges and affirmations to his physical self-efficacy over the course of field camp.

Overall impression

In terms of Ryan's overall impression of field camp, he highlights overcoming the challenges of camp through his determination. He says, "I did well. I was very determined to be successful at the camp and so I guess I persisted through that." He later adds,

> Overall, I really enjoyed the whole experience. Especially looking back on it, I know I was just kind of feeling really sorry for myself on occasion, but now I think of it as a really significant time for me and learning what I enjoy and want to pursue academically and career wise.

Here he emphasizes that despite the constant exhaustion and other challenges he experienced during camp, camp assisted him with his career and academic pursuits. Yet, in doing so, we find that Ryan describes how he found meaning beyond the field camp experience (e.g., attaining good test scores, leadership skills, and overall persistence in a hostile environment), suggesting that some students (especially those from marginalized identities) may need to find these alternate meanings to persist in the discipline.

Impact on academic or career path

In the interviews directly following his field camp experience, Ryan says how field camp helped confirm his interest in furthering his education and pursuing a career in geology. When asked about his future plans to further his education in geology, either through a Master's or Ph.D. degree, Ryan says,

> Well, I was thinking, wow, if I could do [field work] as a research project, even if it is just limited to academia for a few years, that's something I would totally jump at the opportunity to do and I still intend to. I would like to do that. Just like I said, it solidified that.

He felt uncertainty in other majors he previously pursued, but his experiences in field camp enhanced his commitment to geology. He says, "So all these experiences kind of culminated in the fact that, yeah, I want to keep doing this." In the follow-up interview Ryan says he was accepted to a Master's program in geology, however, since COVID-19 impacts prevented field studies, he decided to defer enrollment for a year, giving him more time for research while enrolled in the program. Meanwhile, his geology internship continues providing him with valuable career-enhancing experience.

Regarding his career plan, Ryan was confident in his choice to pursue geology, saying "I felt pretty solidified in my choice [to major in geology]. I did enjoy the academic experiences [of field camp] for the most part. I was like, 'Yeah, yeah, I could do this.'" In the follow-up interview, Ryan's discussion of the field camp experience suggests an increase in his academic self-efficacy and confidence in attaining a successful geology career. He says,

> It definitely boosted my confidence. I feel like I can easily do field work in any career really, because of that experience, because of how difficult it was and the fact that I still succeeded and did well in the camp. Yeah, I've applied to some jobs with field work… Unfortunately, I didn't get those jobs, but I felt confident when they asked me in the interview about my field experience.

Despite some career setbacks, Ryan describes feeling confident that the skills learned in camp will help him secure a future career in geology.

Overall, Ryan's self-efficacy experience shows how, despite setbacks such as exhaustion, unprofessional behavior from

TAs, and various group work challenges, he remains interested in geology and continues to pursue his education and a career in the discipline. However, this does not excuse the impact these negative experiences may have on students with marginalized identities, as we discuss next.

Discussion

Studies suggest field experiences may foster or reduce a positive self-efficacy in students that may contribute to their interest in pursuing the discipline (Baber et al., 2010; Kortz et al., 2020). Our study suggests these field experiences may have a more nuanced impact on students with marginalized identities that both affirms and challenges their self-efficacy. These affirmations and challenges are specific to three types of self-efficacy (academic, physical, and social) that may impact student retention in the discipline. Our findings suggest that some positive experiences may improve self-efficacy (e.g., sense of belonging), whereas negative experiences may decrease self-efficacy (e.g., hostile/sexist climate). Despite experiences that decreased students' self-efficacy, we find support for Deemer et al. (2014) that decreases in self-efficacy does not necessarily translate into a decreased likelihood of pursuing a discipline, since both students describe overall positive impressions of camp and intentions to pursue academic and career paths in geoscience. However, the implications of these experiences may be more significant.

As we reflect on the experiences of Hannah and Ryan, we recognize that the challenges they experience are unlike anything that those in power or those holding socially dominant identities are ever likely to experience during a geoscience field program. Like Posselt and Núñez (2022), Hannah's experience shows some of the ways that women may experience an exclusionary social climate in these field settings. In fact, both students face repeated hostile experiences and were confronted daily with reasons to leave the discipline they enjoy for a discipline that may better cater to societal career norms and expectations, yet they persist by emphasizing their passion for the discipline and their continued interest in pursuing the field, as suggested by Kortz et al. (2020). What does this mean, then, for those students who have a passion for this discipline, but are unwilling to persist through these hostile encounters? Or those students who want to engage long enough to realize their passion, but are shoved out of geoscience spaces due to a hostile climate? It means that until the geoscience discipline embraces diversity and equity in their student body, it will continue losing unique perspectives and future contributions. It also means, as demonstrated in these two narratives, that students begin to find meaning in experiences beyond the field program experience (e.g., good test scores, leadership skills, persistence in a hostile environment) and being there to learn. Why must these students dig so much deeper just to belong in these spaces?

The work of hooks (1984) reminds us that improving the experience of those at the margins, serves to improve the experience for all involved. Field programs that confront a hostile environment allow a space where all students are able to fully perform their identity and where students are able to fully engage with geology without external pressure to conform, to persist, or to be anything other than their authentic selves. Imagine what this would mean for the geoscience discipline, to ensure unique minds and perspectives are incorporated into geologic findings and shaping the trajectory of this discipline.

It is easy to focus on the students' persistence and forget the underlying implications of these hostile encounters. Certain negative experiences, such as sexism, cost barriers (e.g., student jobs), physical ability barriers, or a lack of belonging that exist during field camp, may exist in other field-based (or department-based, including classroom and social events) experiences in ways that deter students who have not yet fostered a high level of identity, interest, sense of belonging, or persistence within geoscience. Students may put a positive spin on their hostile encounters, but ignoring them will not alleviate these impacts on future students. In fact, studies identify how this type of coping mechanism may be used to protect oneself from the negative impacts of their experiences, especially for marginalized individuals in spaces where they are underrepresented (e.g., London et al., 2014). This form of toxic positivity may be internalized in the students, which then bleeds into their recounting of their experiences, and thus into the way we as authors describe their responses—that even though students of marginalized identities encounter these challenging experiences, that they are still able to persist in the field. This narrative further confirms a false and damaging individualistic narrative that embodying persistence is necessary for students of marginalized identities to be a geoscientist, not that this embodiment is forced upon them by external societal forces that determine who and what exemplifies a "true geoscientist."

Limitations

Our study uses retrospective accounts from participants which presents a limitation to our findings. Although participants were contacted for an interview within 6-8 weeks of attending camp, this may have led some participants to forget details of their experiences. The authors also did not directly observe the field programs and therefore we rely on the students' memory of experiences. Additionally, since the focus of our study was to understand negative experiences that may impact students' academic and career pursuits in geoscience, more of our questions were geared toward recounting negative experiences and less directed toward understanding positive experiences. Interestingly, this did not necessarily lead to more negative than positive experiences being recounted, since participants tended to put a "positive spin" on their experiences.

Implications

Our study's findings have implications for the future of field programs. It highlights the role of the instructor in

the student identified experiences, since all experiences relate to field camp program management. This includes the proper training of TAs in content and inclusive pedagogy; student and faculty training on a code of conduct prior to entering the field; setting and enforcing a code of conduct during field camp including an expectation of professional behavior at all times;[1] and setting an overall culture that is intolerant of behavior that is outside of established expectations. An additional consideration we propose is for the larger geoscience community to develop standards of field conduct that are trained and reinforced throughout the entire undergraduate curriculum so that students encounter it many times before they start an extensive field program.

Future studies could expand on this understanding of self-efficacy in field settings by using our framework to include students' academic, physical, and social self-efficacy. Additionally, future studies could examine the impact of this form of toxic positivity on individuals' retention in geoscience through a longitudinal analysis informed by both sociology and psychology disciplines.

Conclusions

Due to the impactful nature of geoscience field camp on a student's persistence in the discipline, our study highlights the experiences students face in these settings so that practitioners, educators, and leaders in geoscience can devise solutions for a more inclusive environment. These two cases demonstrate some ways students from historically marginalized communities may experience field camp. Although both students intend to continue pursuing the discipline, we highlight experiences that may positively or negatively impact a student's self-efficacy and, therefore, interest in pursuit of an education or career in the geosciences. While there are efforts to address equity gaps in geoscience, we must continue to push for changes to the structure of camps to alleviate barriers of cost and accessibility, and changes to camp culture, such as sexist talk and other experiences that are not conducive to developing a sense of belonging. Doing so will create a more inclusive environment where students feel they belong and are valued for their unique contributions to the field.

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