Meeting Reviews

Affective Learning Outcomes in the Field: A Review of the 2021 Undergraduate Field Experiences Research Network Meeting

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Introduction

Ecology and geoscience professionals alike have stressed the value of undergraduate field experiences, ranging from short outdoor laboratories, residential courses at field stations and marine laboratories or geology camps, traveling courses, or week- to month-long research experiences, in the training for future

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careers in these disciplines. Advocates for field experiences highlight their importance in providing students with the opportunity to apply what they have learned in the classroom to a novel, outdoor setting and to practice skills that are needed by professionals in these fields (American Geosciences Institute 2001, Dillon et al. 2006, Easton and Gilburn 2012, Petcovic et al. 2014, Durrant and Hartman 2015, Hix 2015). Though field experiences are seen as important, they can be expensive and logistically complex, and for years field programs have faced challenges related to funding reductions at institutions of higher education (Moore 2001, Smith 2004, Cotton 2009, Fleischner et al. 2017). The global pandemic has made this past year especially difficult for field programs in that many had to rapidly adapt to create virtual field experience equivalents (Barton 2020, Burmeister 2020, Gerhart et al. 2021, Race et al. 2021), drastically reduce the number of students they serve, or cancel their offerings altogether (Swing et al. 2021).

Though field programs have adapted this past year, many are eager to return to in-person field experiences once we begin to reach the other side of the pandemic. When they do, how can they retain design elements of virtual field experiences that help make in-person experiences more inclusive (Stokes et al. 2019)? How can they leverage the findings on the importance of nature on well-being and public health (Hartig et al. 2010, Bratman et al. 2015), brought to light by the global pandemic (Ugolini et al. 2020, Filgueira et al. 2021)? How can field experiences be designed to promote positive affective student learning outcomes (how students think and feel about their experience in the field) in order to create an inclusive learning environment?

Of the body of research on the effects of field experiences on student learning, relatively few studies focus on the effects of field experiences on learning outcomes related to the affective domain (van der Hoeven Kraft et al. 2011, Jolley et al. 2018). To further understand the impacts of field experiences on students' affective development, the Undergraduate Field Experiences Research Network (UFERN) (https://ufern.net/) brought together researchers and practitioners from a variety of disciplines (primarily from ecology, the geosciences) at the March 2021 Virtual Network Meeting to envision the future of undergraduate field education. UFERN hosted lightning research talks in an effort to promote interdisciplinary conversations about research in affective learning outcomes in UFEs. The research talks and group discussions that followed highlighted a variety of areas of emerging research and identified relevant themes related to the importance of affect in field learning that are summarized below.

Emerging Research

Describing student affect in biological field courses through analysis of field journal reflections

David Esparza and Kira Treibergs.—In 2012, the 2012 called for research to define the affective domain in field-based learning. In response, recent studies suggest that field courses in ecology and evolutionary biology (EEB) can support students' affective development (Beltran et al. 2020, Race et al. 2021). However, it has also been found that minoritized students in EEB programs can express discomfort in the outdoors (O'Brien et al. 2020). To understand the nuances of student affect in response to field biology education, authors D.E. and K.T. asked undergraduate students (N = 54) enrolled in an introductory field biology course to write weekly reflective field journal entries over a semester. Following, they conducted inductive and deductive content analysis of student reflections (n = 743) based on van der

Hoeven Kraft's (2011) Model of the Affective Domain for the Geosciences—a framework describing student affect in response to field-based experiences. The results revealed five main components of the affective domain in field biology courses: (1) Identity; (2) Motivation; (3) Connections to Nature; (4) Emotions; and (5) Prosocial Attitudes. Broadly, these results elucidate students' affective responses to field biology curricula and can further aid instructors in identifying field course design elements that promote student affect.

Diversity and skills development for fieldwork in undergraduates

Ajisha Alwin, Karina Cortijo-Robles, and Ahinya Alwin.—Our study focuses on diversity and skills development at undergraduate fieldwork experiences and employers' preferred skills for entry-level field positions. In our study, we look at employers who recruit for entry-level positions in field ecology/biology research. Employers who pick their employees from recently graduated students from undergraduate field programs, they look for specific skills. We broadly divided fieldwork skills into three categories, and they are transferable skills, technical skills, and program-specific skills (Alwin et al. 2021). Undergraduate researchers expressed their focus on technical skills during the webinar interview. However, employers said that they can train the recruits for most technical skills and so transferable skills are valued more.

Fieldwork experiences are great opportunities for developing skills in undergraduate students. At the webinar interview, undergraduates pointed out the benefits of a diverse field environment and the setbacks of lower diversity in field research for underrepresented students. Moreover, they mentioned that relationships with peers and mentors who were from similar backgrounds played a significant role in their fieldwork experience.

The next topic discussed was the accommodation of differently abled students. Employers and undergraduate field educators expressed that they can offer accommodations for students with certain disabilities but are eager to develop programs with resources to accept more underrepresented students with severe impairments.

Using cultural-historical activity theory to interpret student and program outcomes at Harvard Forest

Manisha V. Patel, Andrew L. McDevitt, and Aaron M. Ellison, Sound Solutions for Sustainable Science.—The Harvard Forest Summer Research Program in Ecology (HF-SRPE), an NSF REU Site, provides undergraduate students an immersive field research experience in ecology. Since 2005, we have used a series of surveys to understand whether HF-SRPE was having a positive impact on student learning and scientific practices. We found that the absence of prior laboratory research experience and the perception of being a respected member of a research team were strongly and positively associated with affective and practical learning gains (McDevitt et al. 2016). Our results also highlight differences in attitudes and behaviors toward STEM, with higher variance among minoritized students who are traditionally underrepresented in science (McDevitt et al. 2020). Additionally, over 70% of HF-SRPE alumni have obtained advanced degrees and work in ecology and environmental sciences. Although these findings suggest that HF-SRPE had positive short- and long-term gains, these surveys could not identify causal pathways. Therefore, we are now revisiting these data using cultural-historical activity theory (CHAT) as a theoretical framework. CHAT is a sociocultural learning theory that helps contextualize student learning experiences. Because CHAT also is a system-based approach,

we can use it to guide and refine programmatic assessment and generate testable hypotheses related to learning outcomes.

Exploring student perceptions and values in a community-engaged 4DEE field experience

Luanna B. Prevost.—Community engagement has been shown to foster students' ownership of learning and support the success of students from historically marginalized populations (Einfeld and Collins 2008, Brownell and Swaner 2010). In this study, a community-engagement project was used as a vehicle in a field botany course designed in alignment with The Ecological Society of America's Four Dimensional Ecology Education framework (Klemow et al. 2019, Prevost et al. 2019). Students in the course partnered with a local community development center that supports economic and social development projects in a demographically diverse community. In initial phases of the study, student reflections were the main form of documentation of student experiences during the course (Eyler 2002, Sanders et al. 2016). Preliminary qualitative coding themes that emerged focused on three roles that students perceived themselves taking on during the project: learner, educator (knowledge provider), and/or collaborator (co-creator). However, reflection data collection was not completed in response to the COVID-19 pandemic. Once in-person events can resume, the second phase will use survey data to examine what values and interests about natural spaces students and community members bring to the project, and how value-sharing influences students' perceived roles.

Low-stakes, high impact: An introductory field course as a model to increase retention in the biological sciences

Alexandra Race, Roxanne Beltran, UC Santa Cruz; and Erika Zavaleta, UC Santa Cruz.—We are interested in the impact field courses can have on student retention in biological sciences majors (Beltran et al. 2020). We looked specifically to a 2-unit introductory field course with no prerequisites, Introduction to Field Research and Conservation, to better understand how field courses can lead to gains in affective outcomes that lead to persistence, like self-efficacy, science identity, and sense of belonging (Hanauer et al. 2016). We found that course features that supported inclusion (Zavaleta et al. 2020), provided holistic support, focused on community building (Race et al. 2021), and allowed for multiple inquiry-driven group research opportunities created spaces for student gains in the above-mentioned affective outcomes. When designing field course experiences, we suggest attention be paid to the "5 I's"- Inclusion, Immersion, Interpersonal, Iteration, and Inquiry-driven- to support psychological outcomes associated with persistence in the sciences (Race et al., 2021). Additionally, we argue for a flipped curricular structure in biology majors—one that puts research at the front of the major experience—as a tool to improve retention in and diversify ecology and evolutionary biology.

The influence of affective outcomes on scientific literacy and future science plans in the field station setting

Stephanie Shaulskiy.—Previous literature finds many benefits to participation in field experiences (e.g., Mogk and Goodwin 2012, Streule and Craig 2016, Beltran et al. 2020, Petcovic et al. 2020). Thus far, the mechanisms for how these benefits develop across field experiences are still unknown. The present study allows us to explore these mechanisms by examining student outcomes in multiple kinds of field courses

and on-campus courses over multiple years. We found positive associations between the field station setting and perceived scientific understanding as well as future motivation to take more science courses. These relationships were mediated by both class learning goal orientation (a focus on mastering and understanding course content to improve oneself) (Meece et al. 2006) and class belonging (the perception of being included, valued, and accepted in the class setting) (Goodenow 1993). Mediation analyses were significant when class learning goal orientation and class belonging were tested individually as single mediators as well as when they were examined together in the same model. Findings demonstrate the important role that both class learning goal orientation and class belonging play in explaining the benefits of field experiences and have implications for ways to continue to provide more inclusive educational experiences for students.

Student perceptions of the benefits and function of rest during undergraduate field experiences

Alison Jolley and Alexander J. Watson, University of Canterbury.—Provision of adequate rest is essential for students to engage in meaningful learning. However, limited studies have investigated how rest is provided to students and what impact this has on their perceptions of fieldwork (e.g., Scott et al. 2019, O'Connell et al. 2020). In this mixed methods study, students were interviewed (n = 16) about their perceptions before and after a rest day and surveyed about their expectations and preferences for rest. Preliminary findings suggest that students recognize rest as important for both physical and mental health, and expect about one day per week of rest on field experiences at least three weeks long. Some students used rest time to be alone and connect with support systems outside of the field environment, whereas others used the time to build relationships with peers inside the field environment. However, all students felt that their behavior supported more connected and meaningful group work on subsequent days. Therefore, provisions for rest should offer students flexibility and agency to engage in a way that supports individual needs for physical and mental recuperation. Further research should investigate links between rest, social well-being, and other field outcomes to better support inclusive experiences for all students.

Affective outcomes of US-based field courses in the natural sciences

Xoco Shinbrot and Kira Treibergs.—Field courses have experienced a precipitous decline in recent years (Fleischner et al. 2017) so synthesizing data from case studies on how field-based courses influence student outcomes is critically important for demonstrating impact. For that reason, we conducted a team-based systematic scoping review—an evidence synthesis approach with the goal of providing an overview of the available literature—to evaluate what cognitive, affective, behavioral, and skill-based outcomes result from participation in US-based undergraduate field courses in the natural sciences. We extracted data from 61 articles and found that the majority of articles on affective outcomes focused on students' self-confidence, attitudes toward the course, and connection to nature. However, data quality on affective outcomes tended to be low, for example, almost half of evidence on student confidence was considered anecdotal instructor observation rather than empirical systematic data collection. Our results suggest that while published affective outcomes of field courses are of interest to both researchers and practitioners, they deserve an expanded and more rigorous focus in the literature. We call for future research in natural science field courses in US-based institutions to assess affective outcomes beyond measures of student confidence, to include factors such as sense of place, social connection, or identity.

Themes from the Group Discussions

Following the interdisciplinary research talks, the meeting participants moved into breakout rooms to discuss three prompts. Participants provided input on how education research can inform inclusive practice, how research on affective outcomes could be improved and identified what is currently missing from the research on field experiences. Common themes from these discussions are provided below.

Prompt 1: How can research on affective outcomes translate into inclusive practices?

The three broad themes that emerged from this discussion were (1) UFE design elements, (2) centering experiences on the whole student, and (3) ways in which research can be translated into practice. Discussions emphasized the need to fully characterize the breadth of field experiences available for students. Meeting participants described how being reflective and creative in the modes of instruction, such as using place-based instruction (Semken and Freeman 2008) and incorporating virtual experiences (e.g., Arora and Khazanchi 2014, Dalbotten et al. 2020, Whitmeyer and Dordevic 2020) can make field experiences more relevant and accessible even in the time of COVID. Others described how student orientation to the field is important, not only in terms of how students are introduced to the field, but also how gradual increased exposure to the field setting should be scaffolded within the course design. There was also discussion about how multiple field experiences over time promotes development of student interest (Hidi and Renninger 2006). These experiences could be embedded in courses throughout a major and/or combined with experiences outside the classroom. Research-informed design can help address barriers (e.g., applications and costs) and encourage practices that promote inquiry-driven learning with attention to student needs.

Participants also noted the importance of considering how students come to a field experience with intersectional identities, such as gender, race, religion, or sexual orientation, which can lead to overlapping systems of discrimination (Crenshaw 1991). This intersectionality influences both the way students experience the field and how they leave the experience. Participants commented on how being part of a "community" (or not part of a community) can influence a student's identity and discussed community in a variety of contexts including "sense of community" (interpreted here as sense of belonging—O'Brien et al. 2020), community of support for students, and scientific community. Participants noted that access to a scientific community of practice (Lave and Wenger 1991, Streule and Craig 2016) is important for student science identity development. Examples for this topic included incorporating community-building activities for students and also providing opportunities for students to interact with professionals during a field experience.

Lastly, participants suggested a need for compiling best practices in field education and with linking theory to instruction. This effort would require professional development opportunities that would help guide practitioners in implementing research-based design and instruction.

Prompt 2: How can we improve the theoretical and methodological approaches to studying affective outcomes in undergraduate field courses?

This discussion brought forth themes related to (1) theoretical grounding, (2) interdisciplinary focus, (3) research scope, and (4) including practitioners in the research. The discussions in the breakout

groups identified the need to better support research on affective outcomes through increased theoretical grounding. Theories such as critical race and feminist theories (Delgado and Stefancic 2001, Brayboy 2013, Hughes 2016), social cognitive career theory (SCCT) (Lent et al. 1994), and cultural-historical activity theory (CHAT) (Engeström 1987, Foot 2014) were all noted as potential conceptual frames through which the work on affective outcomes could be approached and analyzed. How research design is conceptually framed shapes the future direction of the field. If we maintain positivistic approaches, without paying attention to the overlapping impacts of power, structural constraints, and intersectional identities, we can overlook important factors that shape student experiences in the field.

Meeting participants also emphasized the need for an interdisciplinary focus in both the theoretical and methodological approaches to this research, which is often only conducted in biological and physical sciences. Participants noted that drawing from other disciplines dismantles the siloing effect and produces findings that can reach a broader audience. Example areas from which the research on affective outcomes could draw included education (e.g., science education, environmental education, arts education, informal science education, culturally relevant pedagogy), psychology, anthropology, critical race and ethnic studies, and disciplinary practice (e.g., environmental interpretation).

Participants also called for studies with a more comprehensive research scope to include the study of multi-dimensional outcomes (e.g., a systems approach) and comparison studies among field programs (e.g., inquiry-based field experiences, research-based field courses) in order to identify if particular affective outcomes are related to design elements within a field experience. Lastly, participants indicated that practitioners needed to be stronger partners in this research. To accomplish this goal, various resources need to be developed including identifying a common language and or/creating a glossary of terms, training for practitioners, and an accessible database of assessment tools.

Prompt 3: What is currently missing from research on field courses/experiences?

The three themes that came from the participant discussion were related to (1) research on mentor and instructor training, (2) studies with broad scope, and (3) specific gaps in research on affective outcomes. Participants suggested a need for more research about professional development for both faculty and teaching assistant (TA) field course instructors. Also suggested was the development of field-specific versions of mentor training, adopted from the Center for the improvement of Mentored Experiences in Research (CIMER): Entering Mentoring training (Pfund et al. 2015).

Participants also discussed the need for more studies with broad scope—studies that include a variety of field contexts (e.g., REU-style field research, course-based field experiences)—in order for findings to be generalizable across field courses and to investigate whether findings are generalizable across different disciplines and institutions. Most often participants mentioned the need for multi-program studies and cross-institutional comparisons, which is a similar call made by other recent publications (e.g., Beltran et al. 2020, O'Connell et al. 2020). Multiple participants mentioned needing research about the impact of multiple kinds of UFE formats on supporting important student outcomes. This valuable research can inform UFEs' place in future practice and the development of different formats (e.g., evening, weekend, short-term, on-campus, remote). Participants also discussed the need for longitudinal data to better

understand long-term impacts on affective outcomes and persistence. One participant mentioned the idea of literature reviews and meta-analyses that summarize what is known across programs and across studies and where gaps remain and presented the GER Strength of Evidence pyramid as a possible framework to use (St. John and McNeal 2017).

Participants mentioned several specific gaps in the field education research corpus as it relates to affective outcomes in UFEs. Potential directions for future investigations on UFEs included the following: (1) student social behavior and outcomes; (2) understanding student development of critical thinking skills; (3) defining short- and long-term behavioral outcomes (e.g., future engagement in undergraduate research, retention in the major); and (4) how best to teach responsible and ethical conduct of field research.

Conclusions

The findings from the research talks and discussion groups highlighted the need for larger scale studies across field programs to consider how field experiences address affective outcomes. UFERN was funded to facilitate this work and has fostered new research collaborations that are taking on research questions related to student affect. The meeting also highlighted how future research and collaborations need to be interdisciplinary and the benefit to including both practitioners and social science researchers in this work. Furthermore, field experiences are common across many disciplines. UFERN has been successful in bringing together practitioners and discipline-based education researchers from ecology and geology and seeks to further widen its disciplinary reach. We see support for this interdisciplinary work from the UFERN meeting participants who responded to the post-meeting survey. They indicated that sharing and connecting across disciplines was one of the most valuable aspects of the meeting. We believe that research about affective outcomes in undergraduate field experiences and figuring out how to translate those findings into inclusive practice needs continuing interdisciplinary collaboration.

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