Fostering Inclusion in the Life Sciences through Course-Based Field Research Experiences

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Introduction

Retention of marginalized students is a major focus of many higher education institutions with the goal of diversifying and increasing innovation in the Science, Technology, Engineering, and Mathematics (STEM) workforce (NCSES 2023). Life sciences, biology in particular, is lagging behind in attracting and retaining students from marginalized identities (Cronin et al. 2021). Thus, it is critical that biology fields identify and apply strategies that build more inclusive academic programs (Cronin et al. 2021; Zavaleta, Beltran, and Borker 2020).

Early field-based research experiences are high-impact interventions that attract students and build scientific networks that propel STEM careers (Shinbrot et al. 2022; Shortlidge et al. 2021). Field experiences can increase students' sense of belonging, scientific identity, and sense of place (Race, Beltran, and Zavaleta 2021) while also decreasing the academic gap generated by systemic practices that negatively affect students of marginalized identities (i.e., opportunity gap) (Beltran et al. 2020). The positive outcomes of field-based experiences could be attributed to implementing course designs featuring elements of High Impact Practices (HIPS) (Kuh and O'Donnell 2013). For instance, a common feature of field-based courses is immersive inquiry-based research projects. In alignment with the HIPS elements, the projects provide opportunities to reflect, integrate learning, communicate, and scale performance expectations at a high level for students. In addition, students interact with a diverse and supportive group of faculty and peers about meaningful subjects in circumstances that positively challenge students (Kuh and O'Donnell 2013).

However, field experiences remain underutilized tools for inclusion and retention of marginalized students in science (Fleischner et al. 2017; Shinbrot et al. 2022). Sometimes, field experiences might even act as barriers due to antiquated recruitment methods and course design (Clancy et al. 2014). Recent research supports using validated assessments and inclusive pedagogy to develop these experiences (Shinbrot et al. 2022; Shortlidge et al. 2021), and to remove entry and participation barriers (Zavaleta et al. 2020). Here, we showcase 1) how we used assessment and evaluation strategies to determine the efficacy of field-based experiences in biology and 2) how we used these data to develop a new field–based course into a departmental intervention to foster inclusion of marginalized student populations in the life sciences.

Case Study: From Field Experience Assessments to a Major-Wide Inclusive Intervention

1. *Determining the efficacy of field-based experiences in biology.* Our team **accessed registrar data and administered longitudinal surveys** to understand how field-based courses at a four-year Hispanic-Serving Institution influenced student outcomes. Similar to the positive student outcomes found when implementing other HIPS (Sweat et al. 2013), we found that field-based courses are correlated with decreasing the opportunity gap for marginalized student populations by increasing gains in self-efficacy, major retention, and graduation rates (Beltran et al. 2020).

   To better understand the apparent high impact of field courses, we engaged in a **longitudinal case study** of an introductory field-based course that is open to all majors and is the credit equivalent to a lab section. We used a **pre- and post-survey strategy** to measure student outcomes, and **journal reflections and focus groups** to understand students' experiences (Race et al. 2021). Project ownership and student identity gains were highest among students from marginalized identities by the end of the field-based experience, consistent with other HIPS (Sweat et al. 2013). Qualitative data identified peer community, mentorship, and team-based experiences as main factors predicting student persistence in biology (Race et al. 2021).
2. *Developing a new field-based course into a departmental intervention to foster inclusion.* We revamped our field course design to incorporate elements from our persistence-in-biology framework (Race et al. 2021) and inclusive design principles from other research seeking to facilitate inclusion in ecology-related fields (O'Connell et al. 2022; Zavaleta et al. 2020). We prioritized experiences that were **inquiry-led, iterative, collaborative, and immersive**, with opportunities to increase a student's **scientific network**. Our team suggested our department **offer such a field-course to all incoming biology major students as a gateway to the major**, also promoting inclusion and retention of marginalized student populations in our curriculum.

   The new course, Field Biology in Practice, is offered to all first-year, second-year, and transfer students. We applied outreach strategies to increase students' awareness and reduce perceived barriers to participation (Zavaleta et al. 2020). The course has run successfully for three quarters with a total of 174 students, of which 42% belong to a marginalized race within Ecology and Evolutionary Biology (40% White, 20% Hispanic or Latino, 18% not specified, 17% Asian, 4% Black or African American, 1% American Indian or Alaska Native). The course provides opportunities to produce innovative research (inquiry-led research skills) with at least two team research projects (collaborative and iterative). Students also take field notes about research, nature, and personal experiences

outdoors (reflective). Finally, the students travel to different local ecosystems (immersive) where they meet environmental practitioners and researchers at different career stages (amplifying networks).

In line with the Undergraduate Field Experience Research Network (UFERN) model (O'Connell et al. 2022), the course is continually revised through assessments that target our course goals and objectives. We use modified pre- and post-surveys based on the Persistence in the Science (PITS) instrument (Hanauer, Graham, and Hatfull 2016), as well as student reflections and interviews to assess affective and behavioral outcomes. Early results indicate that students' experiences are impacted by the course. For example, students self-report gains in "feeling welcomed to, and connected with, the STEM community at their university" ($X2(4, 218)=57$, p-value< 0.001). We encourage other practitioners to determine which assessment tools best meet their needs using the UFERN toolkit (Shortlidge et al. 2021).

While still at the beginning of implementing this field course as an intervention to foster inclusion, we will continue evaluating outcomes by using institutional data to track longer term outcomes. We envision others using similar approaches to determine how field-based experiences can better serve their particular student population.

Conclusion

Since Fleischner et al. (2017) highlighted the decline of field courses in higher education institutions in the United States, limited work has been done on assessing the value of these experiences. Our research on field-based experiences demonstrates the power of assessment tools for implementing evidence-based course design and institutional changes. Inclusive field-based experiences are designed around key features of high-impact practices, suggesting that wide implementation of field experiences across higher education institutions can have profound student benefits. Our research and combined learned experience teaching field-based courses provides an example of how validated surveys, qualitative methods, and institutional data are powerful tools that practitioners can use to shape an inclusive future for field-based experiences.

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