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Creating Field Experiences to Promote Scientific Learning

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Abstract

Scientific learning in our complex world is undergoing rapid transformation. Field experiences to promote scientific learning are at the forefront of best practices as science educators strive to inspire students with hands-on active learning strategies that foster innovation, creativity, and revitalize the educational experience. Field experiences in the sciences also promote the development of place-based understanding. Students who engage in field experiences have greater opportunity to cultivate critical connections to real places that transform abstract concepts into tangible realities [1]. Students engaged in the field of biology were positively impacted by field experience. Through their work in the field, the students were able to enact science autonomously; they engaged with peers and teachers in specific ways and developed new understandings about research and epistemology founded on their experiences in the field [2]. The goals of this presentation and paper are to share knowledge of creative field experiences relating to the biological sciences. The multidimensional aspects of field experiences as essential components to scientific learning are comprehensive and provide strong links and valuable information that contribute to expert teaching and learning. Emphasis is placed on the creation of field experiences that will challenge students and encourage them to excel as they tackle complex curriculum topics. The presenters will provide resources to support students and educators as they share knowledge, best practices, and strategies for success in field experience design.

Keywords: *Field experience, Scientific learning*

1. Introduction

In the natural sciences, field experiences are a transformative right-of-passage, enabling the translation of skills and knowledge for students wishing to pursue a professional or academic career [3]. They are essential for community building and networking. These experiences emphasize applied knowledge, critical thinking, and transferable skills that are critical to future employers. While the value of these experiences can translate across a range of educational audiences, in this paper we focus on Undergraduate Field Experiences (UFEs). UFEs are created to optimize engagement with the natural world or to mimic a field experience in the lab or virtually [4]. These opportunities provide hands-on learning that is integral and essential to scientific training [5]. They also have been shown as a way to foster belonging and create a sense of community. Studies have shown that building a sense of community is a critical factor for improving student retention rates [6].

While the demand for STEM professionals has never been greater and more students than ever are seeking an education in the sciences, support in higher education for high-impact practices has diminished. Provisioning for long-term research projects and facilitation of field experiences by institutions of higher education has also declined [7]. UFEs often require educators with a high-level of expertise paired with mentorship responsibilities that demand a singular level of commitment. To experience the greatest learning outcomes, students need academic institutions to actively support field stations and promote field experiences, but the litigious nature of these institutions is impeding support for off-campus or out-of-the-classroom activities.

At the same time, the global pandemic that transformed lives and workplaces also had a lasting impact on increasing the reliance of online educational activities. While a crisis in field learning grew due to a scarcity of support, expertise, and resources, COVID-19 shifted the focus of higher education to a virtual world. This change promoted an independent, solitary educational model that makes offering and accessing field research more challenging [8]. The COVID-19 pandemic interrupted STEM education and brought innovative methodologies with field approaches that required shared transport or travel to a standstill. Community building accompanied the loss of those opportunities [9], however the increasing red-tape of liability grew during this global disruption. Here, we present several examples of ways to incorporate hands-on and field learning back into the modern classroom.

2. Building Field Programs

Undergraduate field research can provide transformative experiences and has been shown to increase engagement and belonging, improve learning outcomes, and enhance career development. However, when developing field programs, it is necessary to consider place- and project- based goals, accessibility, and inclusion to promote best practices. Programs must promote diversity, equity, and inclusion. Field experiences are an opportunity to expand rather than contract those differences by taking advantage of engagement among students and with their communities. Inquiry-based research can help overcome barriers to participation and increase representation [8]. For students from underrepresented groups, barriers may be financial, physical, cultural or social [10]. By carefully cultivating field experiences and the curriculum surrounding those learning opportunities, those barriers can be overcome. Broadening participation and incorporating cultural and racial perspectives will benefit ecological research planning, implementation and teaching because those individuals asking research questions are a part of the social, ecological, community and need to be a part of the natural resource management conversation [11].

In the natural sciences, a connection to the landscape in a place-centered education is critical for a knowledge transmission and mastery of skills relating to ecology, natural resource, and conservation careers [3]. This focus on place-based education fosters an understanding that emphasizes solving real-world problems [8]. This connection to field stations and research sites has been shown to positively correlate with scientific literacy and future career planning [5].

Students in the sciences need to develop transferable skills that aid in job acquisition. However potential employers have stressed that there is a noticeable gap in student capacity and employer expectations with regard to field training [12].

3. Examples of Undergraduate Field Experiences

The natural sciences have always fostered a community of research focusing on the acquisition of skills through application. When reviewing the benefits of field experiences while comparing the learning outcomes of knowledge, affect, behavior, and skill, knowledge gains consistently reported as improving factual and conceptual understanding, metacognition, and concept retention [7]. We will discuss examples of field experiences from laboratory, domestic field courses, international study abroad, and teaching programs.

3.1 Laboratories and Campus Open Space

Many college and school campuses have gardens, arboreta, and natural areas that can be utilized for field skill acquisition in the natural sciences. Going outside offers a welcome change of pace and students are often relieved to explore beyond the traditional classroom space. These spaces also encourage educators to develop creative activities that are not constrained by an indoor space. STEM disciplines have the unique advantage of being designed with specific laboratory time that is designated for hands-on experimentation and exploration. Laboratories offer science instructors the freedom to explore inquiry-based curriculum and demonstrations to reinforce conceptual ideas. Science labs are built around the construct that active learning is necessary for knowledge acquisition.

3.2 Domestic Study Away

Domestic study away programs offer all of the rich opportunities of a study abroad experience but have the added advantage of training our student populations in landscapes they may need to work in for the long-term and provide more accessibility to those students who are prohibited from participation in international activities due to timing, distance, or expense. Cost has been documented to be a repeated barrier to student participation in field experiences [7].

At Georgia Gwinnett College, a field experience exploring the varied and distinct natural communities within the state of Georgia was developed into a Temperate Biology field course. This course has been carefully designed to expand biological learning in the biological and environmental sciences through the expansion of collaborative and hands-on learning. In the class, students have the opportunity to visit and study a wide range of landscapes including the varied biodiversity that calls those natural communities home. Expenses are a fraction of the cost of an international experience, eliminating the barrier of cost that might be prohibitive for many students. Students participate in cooperative research activities which promote belonging and a sense of community that extend beyond the length of the course and provide them with a network of cohorts that serve as a support system throughout their degree program. In each of these areas, students collect artifacts and complete hands-on investigations of the environment. These intense, connected and cooperative activities culminate with field collections resulting in a portfolio and final presentation of the accomplishments and endeavors.

3.3 Study Abroad: Thailand and Ecuador

Study Abroad experiences offer a unique opportunity to encourage students to participate in diverse and varied biological areas, while also building a sense of community with their cohort. Interacting with diverse cultures and communities aids in the development of essential skills required to critically engage with the scientific issues of our time.

In a Math, Chemistry, and Biology Study Abroad Program in Thailand, Georgia Gwinnett College students had the opportunity to participate in a water quality assessment research project that integrated curriculum goals from statistics and applied statistics courses, along with tropical biology and chemistry to assess water quality in different river systems throughout the country. Students were then able to present their field experience findings at a conference hosted at the International Student Research Conference on Science, Mathematics, and Technology at Kamphaeng Phet Rajabhat University. In a Study Abroad Program through Georgia Gwinnett College on International Conservation Biology, students have the opportunity to participate in a variety of field experiences in Amazonian Ecuador and the Galapagos Islands. These students volunteer at an animal rehabilitation site and at research stations in the Galapagos. In these international field experiences, students' experience with a unique place and culture transforms learning beyond learning about something into a visceral experience where they have ownership.

3.4 Boisie State University: Field Experiences for Idaho Teaching Certification

Field experiences in Teacher Education programs at Boise State University are designed to promote the continual development of teachers with a compelling emphasis on increasing student learning. The programs provide candidates with the knowledge, skills, and dispositions necessary for teaching. Candidates have multiple opportunities for field experiences in various subject areas and grade levels. These experiences are also designed to include working with diverse student populations. Guided reflection of field experiences from a variety of perspectives fosters the self-analysis and evaluation skills essential for ongoing professional development [15]. Boise State College of Education field experiences support the conceptual framework as the College strives to develop knowledgeable educators who integrate complex roles and dispositions in the service of diverse communities of learners. Believing that all children, adolescents, and adults can learn, educators dedicate themselves to supporting that learning. Using effective approaches that promote high levels of student achievement, educators create environments that prepare learners to be citizens who contribute to a complex world. Educators serve learners as reflective practitioners, scholars and artists, problem solvers, and partners. The activities connected to teacher education field experiences are designed to help foster an inquiry stance toward teaching and are designed to promote the continual development of teachers with an emphasis on increasing student learning. Field experiences incorporated within educational coursework and programs provide candidates with in-depth experiences, which include exposure to all grade levels and the opportunity to work with a multiplicity of diverse student populations. Classroom field experience is the link between formal preparation and full-time, independent teaching. Guided reflection of classroom experiences from a variety of perspectives fosters the self-analysis and evaluation skills essential for continued professional development [15]. Field experiences also support the Idaho Core Teacher Standards in that they ensure that the preservice teacher works with others to create environments that support individual and collaborative learning, encourage positive social interaction, active engagement in learning, and self-motivation. Through field experiences, students in teacher preparation programs have the opportunity to interact in the classroom, understand and use a variety of instructional strategies to encourage learners to develop an understanding of content areas and their connections, and to build skills to apply knowledge in meaningful ways [15].

4. Conclusion

Undergraduate Field Experiences provide opportunities for first-hand experiences that encourage "critical thinking, long-term retention, transfer potential, positive attitudes toward science, appreciation for nature, and increased scientific curiosity" [13]. Students who particpate in these experiences consider them to be pivotal in their academic careers. Field courses have been shown to reduce equity gaps and promote retention and self-efficacy of students from historically underrepresented groups [14]. In the case of teacher education preparation, field experiences are essential in providing teacher candidates with the knowledge, skills and dispositions required to engage with others and become a certified classroom teacher. Additionally, school districts will be willing to hire educators who have been prepared by responsible colleges of education that emphasize field experiences and ensure the quality of their graduates. Beginning teachers will have the confidence that they need to begin their own careers because they have had the opportunity to engage in field experiences that prepare them to for their own professional endeavors. Not only will teacher preparation candidates be

positively impacted, but the students in their classrooms will benefit from their experiences and opportunities to collaborate with other quality educators who have increased knowledge and experience in the field of education.There is an imperative need to collect more empirical data to demonstrate just how important these experiences are in our educational system. If we don't make an effort to quanitfy the value of these high-impact practices, they will be lost [4].

References

[1] Fleischner, T. L. (2017). The Natural World: Why Field Studies Matter.*Research and innovation News.* Retrieved on November 12, 2023 from https://www.openaccessgovernment.org/the-natural-world-why-field-studies-matter/39279/">The natural world – Why field studies matter (openaccessgovernment.org)
[2] Torstein, N.L. (2018). Working and Learning in a Field Excursion. *CBE Life Sciences Education* 17(2). Retrieved on November 11 from https://doi.org/10.1187/cbe.17-08-0185">https://doi.org/10.1187/cbe.17-08-0185
[3] Milam, E. L. (2022). Making Place in the Field, *Isis*, 10.1086/718149, 113, 1:121-127.
[4] Shortlidge, E. E., Jolley, A., Shaulskiy, S., Geraghty Ward, E., Lorentz, C. N., O'Connell, K. (2021). A resource for understanding and evaluating outcomes of undergraduate field experiences, Ecology and Evolution, 10.1002/ece3.8241, 11(23):16387-16408.
[5] Shaulskiy, S., Jolley, A., O'Connell, K. (2022). Understanding the Benefits of Residential Field Courses: The Importance of Class Learning Goal Orientation and Class Belonging, CBE—*Life Sciences Education*, 10.1187/cbe.21-08-0201, 21, 3.
[6] Boyd, N. M., Liu, X., & Horissian, K. (2022). Impact of Community Experiences on Student Retention Perceptions and Satisfaction in Higher Education. Journal of College Student Retention: Research, Theory & Practice, 24(2), 337-365. https://doi.org/10.1177/1521025120916433
[7] Shinbrot, X. A., Treibergs, K., Arcila Hernández, L. M., Esparza, D., Ghezzi-Kopel, K., Goebel, M., Graham, O. J., Heim, A. B., Smith, J. A., Smith, M. K., (2022). The Impact of Field Courses on Undergraduate Knowledge, Affect, Behavior, and Skills: A Scoping Review, *BioScience*, 10.1093/biosci/biac070, 72(10):1007-1017.
[8] Valliere, J. M. (2022). Cultivating scientific literacy and a sense of place through course-based urban ecology research, *Ecology and Evolution*, 10.1002/ece3.8985, 12, 6.
[9] Race, A. I., De Jesus, M., Beltran, R. S., Zavaleta, E. S. (2021). A comparative study between outcomes of an in-person versus online introductory field course, *Ecology and Evolution*, 10.1002/ece3.7209, 11(8):3625-3635.
[10] Morales, N., O'Connell, K.B., McNulty, S., Berkowitz, A., Bowser, G., Giamellaro, M., Miriti, M. (2020). Promoting inclusion in ecological field experiences: examining and overcoming barriers to a professional rite of passage. *Bull Ecol Soc Amer*. 101:e01742.
[11] Bowser, G., Cid, C. R. (2023). Knowing Your Field Community: Elevating the Human Dimension in Ecological Research and Teaching, *Integrative And Comparative Biology*, 10.1093/icb/icad036, 63(1):128-135.
[12] Alwin, A., Geleta, Y., Mourad, T. (2021). Toward Conceptualizing Student Outcomes in Undergraduate Field Programs and Employer Expectations for Field Positions, *The Bulletin of the Ecological Society of America*, 10.1002/bes2.1820, 102, 2.
[13] Manner, B. (1995). Field Studies Benefit Students and Teachers. *Journal of Geological Education*. 43:(2)128-131.
[14] Beltran, R. S., Marnocha, E., Race, A., Croll, D. A., Dayton, G. H., & Zavaleta, E. S. (2020). Field courses narrow demographic achievement gaps in ecology and evolutionary biology. *Ecology and Evolution*, 10(12), 5184–5196. https://doi.org/10.1002/ece3.6300
[15] Teacher Education Early Experience Field Guide (2023-24). Boise State University College of Education.https://docs.google.com/document/d/1QI5e_E1279yE0a5YLbnBVN3UhJ8UeXyuUk5KLxD1i30/edit