Chapter 12: Teaching in the Field

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One of the most rewarding and enjoyable aspects of teaching in geography and geoscience is field instruction. Designing and implementing field experiences can be both an exciting and overwhelming prospect. The reality is that field instruction requires diligent preparation, both in and out of the classroom, if it is to provide successful and meaningful learning experiences. Many geographers and geoscientists are committed to experiential, field-based learning and have written about both the practical and theoretical aspects of successfully teaching in the field. This chapter offers a summary of this helpful literature, while also discussing some of the authors' experiences of "lessons learned" from teaching in the field, and the impact of the recent COVID-19 pandemic on field instruction.

*The authors' discussion encapsulates geography and geosciences in their widest definitions, and much of this discussion is not necessarily discipline specific. However, given the authors' respective specialties in climatology, plate tectonics, and structural geology, many of our specific examples are from these fields.

Field study in geography and geoscience

Field study has a long tradition as a core learning experience in the geography and geoscience curriculum*. At the most fundamental level, field instruction represents the first two phases of learning presented by Kolb (1981): do/feel and observe/record/reflect. If properly designed, field experiences offer students the opportunity to engage in the experiential learning cycle of concrete experience, reflection, formation of abstract concepts, and active experimentation. Generally, in geography and geoscience, this involves engaging with the field, making observations, generating ideas and hypotheses based on observation and academic theory, and then further engaging with the field to test ideas generated (Marvell et al., 2013; Fuller, 2012; Chang and Weng Taipei, 2002; Compton, 1985). For example, geoscience education involves the study of natural processes that have and continue to shape the landscape and internal structure of Earth and other planetary bodies. Thus, to fully understand the evolution of Earth and other planetary bodies, students must directly observe and record geologic processes and their associated features in the field where they occur (Compton, 1985). Opportunities to examine geologic/geomorphic features and/or processes take the form of field trips, which can be either short-term trips to local sites, or long-term trips to potentially distant sites. Students on field trips can make their own observations, collect data, and apply the scientific method the same way researchers do. Field trips provide an unparalleled opportunity for hands-on, interactive learning, and can serve as the capstone experience wherein students apply knowledge, skills, and experiences from their previous coursework.

The advantages of field instruction as an active learning technique are that it increases student satisfaction and enjoyment, provides real-life examples of features and processes presented in a lecture, allows for application of material and collaborative problem solving, increases knowledge retention, and creates a common frame of reference and observational base that can be built upon throughout a course or degree program (Compiani and Carneiro, 1996; Frodeman, 1996; Elkins and Elkins, 2007; Fuller et al., 2000, 2006; Lonergan and Andresen, 1988; Petkovic et al., 2009; Stokes and Boyle, 2009; Thompson, 1974, 1982). In short, more holistic learning and understanding of geography and geoscience can be achieved through field experiences. Specific student learning outcomes facilitated through fieldwork include the development of observational skills and respect for the environment, encouragement of students to take responsibility for their own learning, and exposure to 'real' research techniques (Kozar and Marcketti, 2008; Stokes et al., 2011; Wilson et al., 2017; Bednarz et al., 2013). In addition, students' presence in the field often leads to 'unstructured' experiences, which can stimulate discovery and allow students to engage with relevant topics beyond the scope of the scheduled topic for the day, yet pertinent to the course objectives (Gibbes and Skop, 2022; Tuan, 2001; Salter, 2001). Lastly, it should also not be overlooked that fieldwork often attracts students and is an effective recruiting tool for geography and geoscience programs (Morris et al., 2018).

Field instruction and experiences come in many forms, and this variety of forms can make it challenging to describe the different types of field experience. But a fundamental difference in types of field experiences is duration, which limits the student learning outcomes and specific skills that can be taught or assessed. In addition, the complexity of pre-field trip preparation and logistical planning also aligns with the duration of the field experience. Short-term field trips typically occur over one class period or day, during which students are exposed to features, processes, and/or concepts discussed in a classroom setting During short-term field trips, students typically make observations, collect data, and/or conduct descriptive analyses, which can be associated with laboratory assignments and/or small projects. For example, geoscience students can directly observe and measure an in-situ rock outcrop or fault zone that was previously introduced in a classroom setting via static images (see Tables 1 and 2 for more examples). Mid-length field experiences usually last several days to two weeks and are designed to teach multiple field skills and fulfill several student learning outcomes. During these field experiences, students learn via an immersive experience where they directly observe and touch the landscape. A common example of such a field experience is a 'destination' experience wherein a main goal is for the students to experience and immerse themselves in a new and unique landscape. Examples include 'The Geography of the Outer Banks, NC,' or 'The Geology of Death Valley, CA.'

Long-term, capstone field camps and courses typically involve several weeks of fieldwork in one or multiple locations and often serve as the capstone course for an undergraduate program (Mayer, 1970). Mastering of fields skills is the main student learning outcome, and the final product is a large-scale project that requires students to complete independent field observations, data collection, and analysis and interpretation. The key distinction from short-term field trips is the expectation of students to use acquired skills, experiences, and knowledge from all previous courses to complete projects and ensure success. Students use skills including reading comprehension, verbal communication, critical thinking, and a developed method. For example, students will follow the scientific method by making hypotheses and testing predictions during each day and throughout the entire trip. In addition, a field camp or course can investigate previous findings in academic literature and test published theories or models in the field, thereby learning the research process through first-hand experience. A key component in the design of such a field experience is determining the amount of pre-trip knowledge and preparation provided to students. Generally, students with little field experience require more pre-field knowledge and preparation to achieve a learning outcome and have a meaningful educational experience. Students who are further along in their academic career typically require less pre-field trip knowledge and preparation. For example, more experienced students may be assigned a 'site-unseen' field exercise, wherein students work in a field area without prior knowledge of the location and use all fundamental skills acquired from previous coursework and experiences. In addition, student success is hinged on the constant development and testing of hypotheses through field observations. Such a field experience allows an instructor to assess students' knowledge, skill, and analytical abilities, and determine how successful an academic program is in imparting knowledge and skills to students.

The recent expansion of the use of digital instruction, due to technological advances and adaptations during the COVID-19 pandemic, has started a discussion in geography and geoscience of how to integrate digital instruction into field experiences. This discussion has led to the creation of new labels for field experiences such as 'hybrid', 'online', 'remote', or 'virtual' field teaching (Walshe and Healy, 2017). We will discuss this case in more depth later in this chapter but at the time would like to note that digital instruction should be considered as a new, more inclusive avenue for information delivery and collaboration for field experiences which can result in better field experiences and involvement of a wider student body. However, we stress that field experiences must include a significant, traditional field component and cannot be fully replaced with online teaching.

Beyond the structure of a field experience, the structure of an academic program and how field experiences fit into the academic curriculum is an important consideration for instructors as they design field experiences. If the learning outcomes of a given academic program require students to be proficient in field inquiry and research, students must not only how to observe and collect field data, but also know how to design and manage field research. Such skills and proficiencies must be taught across a series of courses, typically beginning with an introduction to basic observations and interpretations in lower-level courses, followed with discussions of more specific techniques of collecting observations and data and technical communication in upper-level courses. As a final step in the academic program, students complete a capstone course/experience during which students implement and are assessed on the design and completion of an independent field research project.

The student learning outcomes, structures, and challenges of field experiences are comparable for geography and geoscience programs across the world (Yan et al., 2009; Wu et al., 2017; Wilson et al., 2017 and references therein; Scott et al., 2012; Elkins and Elkins, 2007). For example, many geoscience programs in the People's Republic of China require undergraduate and graduate students to participate in both short- and mid-length field trips as part of their coursework (Yan et al., 2009; Wu et al., 2017). The purpose and activities of field experiences in China include learning to identify, describe, and measure Earth materials and structures, often through geologic mapping, and developing a better understanding of rock formation and deformation processes. A key, universal goal of field experiences in China is students' use of the scientific method to analyze and interpret their own observations and solve geologic questions. However, the continued use of field studies in China faces similar challenges as other geoscience programs, including the decreased use and focus of field trips in curricula over the last few decades. This issue in China is particularly evident regarding the long-term field camp/course model, as only few geoscience programs still offer capstone field experiences during which students use the skills, experiences, and knowledge acquired from previous courses. For geoscience programs that continue to offer the capstone field experience, the most effective field camp or course model involves several weeks of dedicated study within a large-scale area, such as geologic mapping within the well-known Zhoukoudian area of Beijing and Beidaihe area of Heibei Province (Wei et al., 2019; Cao et al., 2015). The success of the capstone field camp/course within the Zhoukoudian and Beidaihe areas can partially be attributed to the joint management and student involvement of the Beijing and Wuhan campuses of the China University of Geosciences over the last three decades (Wei et al., 2019; Cao et al., 2015). Whereas the current biggest obstacle to offering student field experiences in China is the reduced focus of field trips in the curriculum, the recent advancement of technology has created new opportunities to compliment traditional field studies, including the use of ‘remote’ or ‘virtual’ field trips, mapping via remotely sensed imagery, and training in mapping software.

Advice for Field Experience Design and Instruction

Once the duration, student learning outcomes, and appropriate placement within an academic program have been determined for a field experience, several important factors cannot be overlooked. Based upon our combined 35+ years of field instruction experience, we offer the following advice for designing field experiences.

1. *Pre- and Post-Field Activities*: Do not forget the time before and after venturing into the field. As a rule of thumb, instructors must schedule, at the least, an equal amount of time for both pre-field preparation/post-field reflection and actual field instruction. The quality of the student learning experience is just as dependent upon this preparation and reflection as it is on the time spent in the field. Proper preparation and meaningful analysis/reflection are often critical to meeting the student learning outcomes of a given field experience. As a result of the COVID-19 pandemic, many instructors have determined that online preparation is effective for pre-field preparation and increases access for students who are employed and may have limited time to participate in a field experience (Day et al., 2023). In addition, while on an extended field trip, unstructured 'free' time is necessary to maintain group morale. This free time can occur as breaks during fieldwork, or in evenings following fieldwork. Such time allows the students to recharge, put the day in perspective, socialize, and monitor themselves mentally and physically. In addition, the free time allows the instructor some time to rest and disengage from instructor duties.
2. *Beware of the 'exotic landscape syndrome':* Textbook and their supplementary teaching resources often offer idealized examples of landscapes that can be quite useful in

illustrating concepts (i.e., the Himalaya as an orogen developed via continental collision, New York City as an urban environment, or the Outer Banks of North Carolina as barrier islands). However, use of these exemplar, or 'exotic' landscapes, can create an under appreciation of the local landscape. There are plenty of examples within the local landscape or community that represent sites described in course material just as effectively as publisher provided graphics. An added benefit of such local field studies is that they can provide data that can be used by local governments or university officials to develop plans and policies, thereby creating an opportunity for students to apply classroom material to real world problems.

3. *Equipment and Materials, Safety, Health, and Inclusion*: The equipment and materials required for fieldwork can be quite extensive. Ensuring that all equipment and materials are available and accessible is key to fostering a positive and safe learning experience for all participants. For example, a multi-week capstone field camp/course requires students to have appropriate outdoor clothing, hiking boots, sufficient water, a Brunton compass, mapping and drafting supplies, field notebook(s), and a first aid kit. Making sure that each participant has these items is imperative for not only their learning but also their safety during the experience. Other equipment and materials that may be shared by the class include global positioning system units, satellite/aerial imagery, and a personal computer for report writing. Furthermore, camping equipment may be required as well as four-wheel-drive vehicles, vehicle recovery gear, and extra spare tires to access remote locations. This example clearly illustrates the need to be thorough and meticulous in

planning for a field camp/course, as proper equipment and materials are the foundation are key to the success of a field experience.

Safety for students and instructors is paramount in the field. Consequently, personnel and students must be aware of the environmental conditions they may be exposed to in the field so that they can prepare adequately. Necessary components include access to ample clean water, first aid supplies, and a means of getting to first responders and/or hospital. Walkie talkies and satellite phones are helpful for remote and large areas. Beyond traditional physical protection concerns, safety issues related to race, gender, religion, and sexuality must also be considered. Without consideration of these issues, students may feel unsafe, which diminishes their ability to engage, participate, and learn. A proactive field strategy should be developed and may include mandatory risk assessment of field experiences, anti-discrimination training, encouragement of bystander interventions and allyship training, reaching out to local authorities before the field experience, identifying and sharing cultural norms of field areas, and documenting hostile encounters (Ackerman et al., 2023; Anadu et al., 2020).

Beyond safety, key forms of inclusivity during field trips include accommodating the time, physical, and dietary needs of all students and personnel (Emery et al., 2020). We must also provide a means of disabled persons to have equitable field experiences, which may entail travel to accessible locations with infrastructure in compliance with The Americans with Disabilities Act. Documents such as digital maps can be provided to students with eyesight disabilities (Carabajal et al., 2017). Access to remote field sites has traditionally been an issue for inclusiveness, so providing a means for field trip transportation and equipment for students who otherwise may not have the ability to access these resources is necessary. Furthermore, inclusivity should not only be associated access for students with physical disabilities. Reduced costs and financial aid are important considerations for providing field access to a broad range of students. An instructor must ask themself, does the time length of a field experience exclude some students due to their work or family commitments? Are alternative experiences provided? In this case, instructors may consider using a series of shorter field trips that cumulatively equal the time spent on longer field experiences. Such student needs must be accommodated for the field experience to be effective to everyone in an academic program.

Impact of COVID-19 on Field Studies

The COVID-19 pandemic caused many academic programs and instructors to modify existing, time-tested types and modes of field instruction, including developing alternatives to face-to-face instruction and/or travel (Bursztyn et al., 2022; Gregory et al., 2022; Rader et al., 2021). Most instructors offered some semblance of a traditional field experience, typically through fully online options, either synchronous or asynchronous, although student learning varied. Day et al. (2021, 1) characterized the instructional pivot caused by the COVID-19 pandemic as “the largest unplanned educational experiment ever undertaken”. Many researchers and instructors have documented how the pandemic and resulting lockdown impacted physical science education, including field education, and how we have learned key lessons from this curricular pivot (Day et al., 2021, 2023; Gibbes and Skop, 2022). Positive lessons learned include students’ value of continued course offerings during times of disruption, such as asynchronous course formats that allow for greater student participation (Day et al., 2023; Gibbes and Skop, 2022). However, the pivot to online instruction showcased students' weaker abilities to critically reflect on learned topics and synthesize broader ideas, despite being competent in making observations (Gibbes and Skop, 2022). Such results have been documented for experiences during non-pandemic times when online experiences substituted traditional field experiences (Kolivras et al., 2012). Thus, the integration of both online learning and field experience is an important lesson in recasting field education from the COVID-19 pandemic (Larsen et al., 2021).

The implementation of face-to-face, hybrid, or fully online teaching formats to supplement traditional field experiences has been a product of not only the COVID-19 pandemic, but also the confluence of other factors. Many school administrators have begun to question the educational benefits of field experiences, arguing that when fieldwork occurs, the experiences tend to be restricted to long-term field camps and courses rather than several short-term trips integrated throughout the program of study (Wilson et al., 2017). Tight university budgets, institutional focus on research, and concerns over litigation, safety, and insurance have also hampered efforts to offer field experiences (Scott et al., 2012; Cook et al., 2006). In addition, untenured faculty who are facing escalating pressure to publish research papers and acquire grant funding have questioned whether they should invest time and resources in a course that may not be rewarded in terms of salary or promotion (Mullens et al., 2012). Furthermore, many academic programs are facing difficulties in offering field experiences due to the burdens these courses put on departmental resources including costs, faculty time, and a need for larger class sizes (Mullens et al., 2012). As a result, the number of offered field camps/courses are declining as degree programs in United States, Canada, United Kingdom, Australia, New Zealand, and China remove such courses from their required curriculum (Wilson et al., 2017 and references therein; Scott et al., 2012).

Although it remains easy for an instructor to get caught up in these external factors, critical reflection, and decisions on how to offer future field experiences provides an opportunity for instructors to assess which teaching method best serves the student learning outcomes of their courses. A common outcome of such reflection has been shifting to online instruction for pre- and post-field activities, which makes field experiences accessible to a wider student population (Day et al., 2023). This outcome capitalizes on the primary advantage of online learning, specifically the increased access and student-paced engagement with the course content (Appana, 2008). Such a hybrid approach to field experiences offers a positive outcome, which is an excellent example of how recent challenges of offering traditional field experiences can lead to the improvement of student learning and success.

Conclusion

Teaching in the field is a rich and rewarding experience for both students and instructors. There are common themes that are salient to all field instruction. These issues include thorough pre-fieldtrip preparation, development of clear learning objectives and themes in field instruction, clear demonstration of tools and techniques, implementation of local field trips, and use of a post-field 'debriefings' that links student activities to course objectives, assessment, and expected outcomes. In short, an instructor should view themselves as an enabler of field instruction. Their responsibility is to take care of the logistics, mitigate safety concerns, and clearly define objectives so that students can focus solely on their field experiences. Even with great preparation, however, field experiences will sometimes not go as planned. Successful fieldwork is a 'trial-and-error' process that can be affected by forces beyond our control (e.g., extreme heat, a flat tire, a closed museum or park, or unideal group dynamics). In addition, resistance to continuing traditional field trips, and the online pivot resulting from the COVID-19 pandemic has provided an opportunity to rethink how field studies can involve online components to offer a more successful inclusive experience. Beyond development of such 'hybrid' experiences, the challenge is to maintain an enthusiasm for and commitment to teaching in the field despite heavy time and effort requirements. When field experiences work, the rewards are unparalleled for both the student and instructor.

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Table 1. Examples of short-to-long field experiences in physical geography and geoscience.

Time Frame	Description of Activities	Student Learning Outcome (SLO)
Short Length (single-day or weekend)	Groups of students observe and measure in-situ rock outcrops and geologic structures (e.g., fault zones, folds) at one or several local sites.	Learn to identify, describe, and measure Earth materials and 3-D geologic structures in the field, and understand their formation mechanisms processes.
	Measure temperature in two thermally contrasting locations.	Observe and record air temperature using a thermometer; Differentiate between different thermal environments based upon air temperature observations.
Medium Length (several days to one week)	Individual or small groups of students perform daily geologic mapping and data collection across a large-scale study site.	Learn to locate oneself on a map; Become familiar with common geologic data collection tools and techniques; Construct a viable geologic map and cross section; Use the scientific method to analyze and interpret large datasets and solve geologic questions regarding the study site.
	Map temperature at student homes and on campus.	Observe, record, and construct an air temperature dataset for two different locations; Identify patterns in time series of air temperature data; Create a map

		that displays air temperature at multiple locations.
Long-Term, Capstone course or field program (several weeks)	Field camp/course wherein individual or small groups of students perform daily geologic mapping and data collection across one or more large-scale study sites.	Master skills related to locating oneself on a map, identifying and describing Earth materials and geologic structures, and using common data collection tools and techniques; Construct one or more professional-quality geologic maps and cross sections; Read and critically review relevant scientific literature; Use the scientific method to analyze and interpret large, new and existing datasets and solve geologic questions regarding one or more study sites.
	Semester long assessment of urban heat island.	Middle-length SLOs + Create a map that displays air temperature at multiple locations; Interpret and explain differences in air temperature patterns based upon location in a rural or urban environment.

Table 2. Examples of short-to-long field experiences in human geography and related fields.

Time Frame	Description of Activities	Student Learning Outcome (SLO)
Short Length (single-day or weekend)	Urban Land Use Survey. Students inventory land use when the neighborhood or town where they live. a neighborhood or district within the city and conduct a survey of land use patterns.	Students gain experience identifying, describing, and categorizing land use into residential, commercial, industrial, recreational; estimating the intensity of use; and mapping the spatial distribution and density of each type.
	Food Access Study: Ask students to study the local food system: where do people get their food; how accessible are these sources; and what types of foods are available.	Students can map the grocery and convenience stores, restaurants, farmers markets, and other food sources where they live. They can focus on the types of foods available (fresh, processed, etc.), price, quality, and accessibility.
Medium Length (several days to one week)	Cultural Heritage Conservation Project: Students identify sites of cultural, historical, and social value that are threatened by neglect or redevelopment.	Students can spend several days working together to map cultural heritage sites, document their histories and architectural features, and estimate the threats to their preservation. Local stakeholders might be involved to outline the conservation plans and strategies they might be developing for the management of this heritage.
	Natural Hazards Vulnerability Assessment: Assign students to study the vulnerability of their community to a	Students can spend several days surveying the physical landscape, infrastructure, and population

	natural hazard that occurs in their region such as floods, earthquakes, wildfires, tornadoes, or hurricanes.	distribution, and interviewing residents and local officials about their experiences with past disasters. Depending on the scope of the project, students can analyze the factors contributing to vulnerability, assess preparedness and mitigation efforts, and recommend strategies for enhancing resilience.
Long-Term, Capstone course or field program (several weeks)	Social Justice and Inequality Assessment: Task students with investigating social justice issues and inequalities within a specific urban or rural context.	This could involve studying housing disparities, access to education, healthcare, and employment opportunities. Students can analyze how these factors contribute to spatial and social inequities. In preparation, students can read, discuss, and critically review relevant literature.
	Climate Change Impact Assessment Using Participatory GIS (PGIS): Assign students to study a region's vulnerability to climate change. They can assess factors such as sea-level rise, extreme weather events, decreasing water supplied, and changing temperatures, and analyze how communities are adapting or mitigating the impacts.	Students can learn to use PGIS to involve community members in mapping spaces and places that are vulnerable to the effects of climate change. Students work in collaboration with local residents to identify and estimate threats. Students can analyze the results in terms of community perspectives and spatial patterns.