Geoscientists' perceptions of the value of undergraduate field education

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ABSTRACT

Learning in "the field" has long held a prominent role in the education of geoscientists. Despite the expense, time, and liability risks associated with fieldwork, field experiences are widely perceived as integral to both learning and professional preparation. Yet, to date, little research has addressed questions of what types of field experiences are valuable and what outcomes are desired. We report findings from survey data collected at the 2010 and 2011 Geological Society of America Annual Meetings that characterize why undergraduate field education is valued within the geoscience community. While 89.5% of respondents ($n = 172$) indicated that fieldwork should be an integral and required part of undergraduate education, only 36.5% agreed that a course in bedrock mapping was necessary. Fieldwork is valued mainly for perceived cognitive gains, such as knowledge and understanding, and for enabling learners to interact with geological phenomena in their natural state. We found few statistically significant differences between self-identified groups, suggesting that students, instructors, and professional geologists hold largely similar opinions about the value of field education. This study helps to identify long-term goals and outcomes of undergraduate educational fieldwork experiences and points to actions needed to align fieldwork experiences with educational goals, workforce needs, and actual learning outcomes.

INTRODUCTION

Few would dispute that fieldwork as a learning activity is highly valued by the geoscience community. Indeed, the following sentiment continues to generate widespread agreement among geoscientists:

> *The reading of books and the study of specimens will never make the geologist; the geologist is made in the field, not in the laboratory.* (Himus and Sweeting, 1955)

Less clear is **why** so much value is attached to fieldwork as a means of educating geoscientists. At its most fundamental, fieldwork provides a means of collecting primary data about Earth, from its atmosphere to its inner core. From an educational perspective, it enables learners to gain knowledge and expertise through direct engagement with the natural world, and to develop the skills necessary for professional practice (e.g., Butler, 2008; Whitmeyer et al., 2009). It is also, for many learners, the first step toward carving their personal identity as a geoscientist by "learning to do what geoscientists do." On the other hand, fieldwork, especially multi-week residential courses and camps, is expensive, resource-intensive, and logistically complex; in addition, the liability issues around taking groups of undergraduates into the "wild" can be daunting (e.g., Boyle et al., 2007).

So closely aligned is fieldwork with the identity of geoscience that its inclusion in the undergraduate curriculum is more-or-less ubiquitous. In the UK and Ireland, fieldwork forms a compulsory, and significant, component of all undergraduate geoscience programs (Boyle et al., 2009; Butler, 2008; Geological Society of London, 2013). The situation in the United States is more variable; however, most geoscience undergraduates receive some training in field methods, typically achieved through a combination of short (day or overnight) field visits and culminating with a "capstone," multi-week summer field camp (Whitmeyer et al., 2009).

While fieldwork per se is not unique to the geosciences, the activity of geologic mapping is. Learning to recognize and map bedrock units, geologic structures, and landscape features in situ is arguably essential to the education of future geologists. However, in reality, the majority of students will never go on to map bedrock in their professional careers. In the UK, the compulsory requirement to complete an independent mapping project means that bedrock mapping is likely to remain part of the undergraduate curriculum for the foreseeable future. The case in the USA is less clear. Although the number of students enrolled in field camps is up, the total number of universities offering field camps has decreased by 60% since 1995 (Whitmeyer et al., 2009). Furthermore, many U.S. universities have dropped "traditional" (bedrock mapping) field courses in favor of more specialized courses (e.g., hydrogeology, geophysics, limnology) in response to the changing nature of the geosciences as a profession. We therefore ask, given the increasing diversity of fieldwork that geoscientists engage in, whether mapping should continue to play such a prominent role in undergraduate education.

So what, precisely, makes fieldwork so valuable to learning geoscience? Pyle (2009) identifies the main goals of field courses as (1) synthesis and application of knowledge; (2) acquiring the field skills and techniques typically required for an entry-level, professional geologist; (3) enculturation into the values and ethics of practicing geoscience; and (4) exposing students to the variety of geologic phenomena they may encounter. Similarly, Mogk and Goodwin (2012) review arguments based on "practitioner's wisdom" (p. 134) claiming that field education yields improvements in students' knowledge and problem-solving skills,

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enhances students' ability to reflect on their own thinking (metacognition), generates positive feelings that lead to enhanced learning, offers direct and immersive experiences of geologic phenomena, and introduces students to professional practice.

This research suggests that field education has both cognitive (knowledge and skills) and affective (emotional and attitudinal) dimensions. Stokes and Boyle (2009) found that students clearly recognized the value of field experiences in enhancing their geologic knowledge and problem-solving skills but undervalued the impact of field education on their personal and professional skills. Other studies have advanced our understanding of how novice to expert geoscientists think, reason, and behave in the field (e.g., Kastens et al., 2009; Petcovic et al., 2009; Riggs et al., 2009; Feig, 2010; Hambrick et al., 2012; Baker et al., 2012) and considered some of the wider social and cultural aspects of field education (e.g., Elkins and Elkins, 2007; Riggs et al., 2007). This recent work has been a critical start toward understanding what we hope to accomplish in field geoscience education and the role that field courses play in the professional preparation of geoscientists.

Our purpose here is to report the first empirically driven attempt to directly capture perceptions from the professional geoscience community of why specific aspects of field education are of value. We specifically consider three research questions:

1. What do geoscientists broadly perceive as the value of undergraduate field education, including fieldwork, courses, and camps?
2. What do geoscientists perceive as the value of bedrock mapping education?
3. How do perceptions of value differ across groups of geoscientists (students, instructors, and industry professionals)?

Our goal is to better understand the role of field training in the education of new geoscientists and contribute to the expanding empirical literature on field-based geoscience education. Finally, we make recommendations for future action that can be taken based on our findings.

METHODS

The study used a mixed-method, concurrent triangulation research design (Creswell and Plano Clark, 2007). A convenience sample of passing volunteers completed a 10–15-minute written survey at an exhibit hall booth at the 2010 and 2011 Annual Meetings of the Geological Society of America. Survey items were modified from two existing instruments (Orion and Hofstein, 1994; Stokes and Boyle, 2009), face validated with two experts, and pilot-tested on a small group of geoscience education graduate students. The final survey consisted of three open-ended questions, 24 Likert-type items (statements to which respondents indicate their level of agreement on a scale of 1–4 or 5), four statements that participants ranked by importance, and 10 demographic questions.

In order to characterize the spectrum of values expressed by participants, responses to the open-ended questions were qualitatively analyzed using a three-step emergent thematic coding procedure (e.g., Creswell and Plano Clark, 2007): (1) authors individually generated lists of ideas represented by the data, then merged lists to develop a coding scheme; (2) the scheme was tested on a random sample of data and revised; and (3) the final scheme was applied to the full data set. Once coded, responses to the open-ended questions were treated quantitatively by counting the frequency of particular ideas (sub-themes). Counts and ranked items were treated as nominal rank-level data for statistical analysis. The 24 Likert-type items were treated as ordinal data and analyzed at the level of individual items using non-parametric tests (after Clason and Dormody, 1994). Statistical analyses were performed in SPSS v. 20. Results of the independent qualitative and quantitative analyses were then compared (i.e., triangulated), enabling the drawing of more robust conclusions than a single data set would allow (e.g., Creswell and Plano Clark, 2007). A detailed description of the study methods is available in Part A of the GSA Supplemental Data Repository item associated with this paper[1].

STUDY PARTICIPANTS

In total, 172 complete, individual surveys (91 from 2010, 81 from 2011) were included in the analysis. Respondents self-identified as a "learner" (50.5%), "instructor" (35.8%), or "industry professional" (13.6%), and completed the survey based on this perspective. Ten participants selected more than one perspective (e.g., instructor and learner); these responses were included and analyzed in all selected categories, thus yielding 184 individual perspectives.

Overall, study participants ranged in age from 19 to 75 years old (mean: 32.5 years). Slightly fewer than half were female (45.9%), and most were white, non-Latino (88.1%), with 87.1% overall working or residing in the USA. The majority of respondents (75.4%) had attended, or planned to attend, a field camp, although relatively few (16.3%) had taught a field course or camp. Learners were dominantly students (45.7% undergraduate, 53.2% graduate), with a mean age of 25 and typically <5 years of work experience. Instructors were dominantly employed in college/academic settings (75.4%) or were graduate students (23.2%), with a mean age of 41. Industry professionals worked mainly in government (46.2%) and industry (42.3%), with a mean age of 48. Additional demographic data are available in Part B of the GSA Supplemental Data Repository (see footnote 1).

THE PERCEIVED VALUE OF UNDERGRADUATE FIELD EDUCATION

Analysis of the open-ended data revealed five broad themes, together with accompanying sub-themes, described below and listed with example quotes from participants in Table 1.

Theme 1: Fieldwork is Important

This category merely claims that fieldwork is important or integral to understanding, learning, or practicing geoscience without further explanation.

[1]GSA supplemental data item 2014174, detailed description of study methods and participant demographics, is online at www.geosociety.org/pubs/ft2014.htm. You can also request a copy from *GSA Today*, P.O. Box 9140, Boulder, CO 80301-9140, USA; gsatoday@geosociety.org.

Table 1. Emergent themes and sub-themes based on analysis of open-ended responses

Theme and sub-theme	Example survey response
Theme 1: Fieldwork is important	Field experience is integral. (learner/instructor)
Theme 2. Impacts on knowledge and skills	
2a. Enhances broad understanding	Field experience is crucial to a well-rounded understanding of any earth sciences field. (industry professional)
2b. Enhances specific skills, knowledge, or practice	Fieldwork is the basis of geoscience through practical methods learned in class to using techniques of observation in the field. (learner)
2c. Develops transferrable skills	Regardless of whether or not a student will directly utilize the field methods, learning to operate and cooperate with others and/or within a group under imperfect conditions is a necessary and beneficial skill. (learner)
2d. Puts theory into practice	Fieldwork is the best way to integrate classroom with the real world. The best way to learn geology is to see it first-hand and learn from experience. (instructor)
2e. Physical interaction with phenomena	Seeing and touching the rocks is necessary for full understanding. (learner)
Theme 3: Personal and emotional impacts	
3a. Inspiring, motivating, exciting, or engaging	Absolutely! … It acts as a "hook" to those students on the fence! (learner)
3b. Develops a geologist's identity	Geologic mapping is the foundation and starting point for all geologic endeavors, you cannot call yourself a geologist if you don't know how to map. (industry professional)
3c. Develops self-awareness and identity	Fieldwork strengthens your knowledge through application and helps you become aware of weaknesses. (learner)
Theme 4: Prepares for career or graduate school	Whether they go on to grad school, or into industry, or any geoscience profession, having at least some field experience helps them to develop an appreciation for several facets of real world geology. (instructor)
Theme 5: Negative aspects of fieldwork	
5a. Time, expense are prohibitive	Field camps, in my opinion, are old fashioned, expensive, and concepts can be taught equally well in shorter field oriented experiments. (instructor)
5b. Negative impact on attitude or interest	This [fieldwork] should certainly be required for geology, but not other branches of geoscience. Keep in mind that not everyone is cut out for fieldwork and/ or harsh field conditions. (learner)
5c. Skills can be learned elsewhere	Students can learn methods from field camp elsewhere, in research in the field as an undergrad through an REU [Research Experience for Undergraduates program] or through their own. (learner)
5d. Too specialized for all sub-disciplines or careers	Some specialties do not focus on bedrock mapping. (industry professional)
5e. Not all students are interested	Only if these specific skills apply to the student's area of focus. (instructor)
5f. Should be recommended but not required	No [not necessary], though I do believe it should be strongly encouraged. (learner)

Theme 2: Impacts on Knowledge and Skills

The knowledge and skills gained by field experience are *products* of learning (sub-themes 2a–2c). These include cognitive gains, such as knowledge and higher order thinking skills (Bloom, 1956), together with practical skills (Dave, 1975). Three relevant sub-themes were identified. First, fieldwork teaches students to integrate concepts and broadens their general understanding of geoscience. Second, fieldwork develops the skills and knowledge specific to understanding and "doing" geoscience. Third, fieldwork teaches skills that transfer to other fields, such as cooperation, time management, and independent thinking. Theme 2 also addresses the *processes* by which students gain knowledge and/or skills through fieldwork (sub-themes 2d and 2e). The immersive nature of fieldwork provides the physical context for geoscience, allowing students to apply their knowledge to the real world. Embedded within this idea is the notion that physical interaction with the landscape and rocks is the means by which this understanding of geoscience is attained.

Theme 3: Personal and Emotional Impacts

As well as promoting cognitive gains, learning also impacts motivation, attitudes, and values—collectively termed "affective responses" (Bloom, 1956; Krathwohl, 2002). Three key ideas emerged within this theme. First, fieldwork impacts positively on students' attitudes and feelings toward geoscience (e.g., Kern and Carpenter, 1984; Boyle et al., 2007). Second, fieldwork is an enculturation experience that enables students to develop their identity within the community of professional geoscientists. Finally, fieldwork can promote self-awareness by helping students to recognize their personal strengths and limitations.

Theme 4: Career Preparation

This theme concerns the practical outcome of preparing students to progress further in geoscience, either to graduate education or to geoscience careers.

Table 2. Results of quantitative analysis of open-ended questions

Questions		All respondents (n = 172)	Learners (n = 93)	Instructors (n = 66)	Industry professionals (n = 25)
1. Should fieldwork be an integral and required part of undergraduate programs?	% agreement	89.5	91.4	87.9	88.0
	% disagreement	1.7	2.2	1.5	0.0
	% mixed	8.1	6.5	9.1	12.0
2. Should a geologic field methods course or camp be required?	% agreement	79.4	76.3	78.5	87.5
	% disagreement	6.5	6.5	7.7	0.0
	% mixed	13.5	16.1	13.8	12.5
3. Should a field course or camp focused on bedrock mapping be required?	% agreement	36.5	35.5	38.5	37.5
	% disagreement	28.2	30.1	23.1	20.8
	% mixed	29.4	28.0	33.8	37.5

Note: Percentages within each category do not total to 100% because a small fraction of responses were too ambiguous to be interpreted. Results of a Pearson chi-square test for independence indicate no statistically significant differences in agreement frequency between categories of participants.

Theme 5: Negative Aspects

Many responses stated reasons why fieldwork should not be required in undergraduate education, and these are grouped into the final theme. Several sub-themes emerged. First, many respondents recognized that field camps are expensive and that the financial burden and time commitment may be prohibitive to some students. Second, some students simply do not enjoy fieldwork, and a requirement to undertake outdoor work may discourage those students from pursuing geoscience majors in college, and subsequently from careers in geoscience. Third, respondents recognize that skills taught in multi-week field courses or camps can be learned elsewhere, either via undergraduate research experiences or on shorter, targeted courses. Fourth, the skills taught in field courses and mapping camps are too specialized for all fields within the geosciences. A related fifth idea is that field experience should be tailored to students' areas of interest. Finally, several respondents commented that fieldwork should be offered and recommended but not compulsory, due to the challenges mentioned above.

The themes emerging from our qualitative analysis are consistent with those identified from previous research into the value of field education (e.g., Pyle, 2009; Stokes and Boyle, 2009; Mogk and Goodwin, 2012) indicating broad consensus within the geoscience community on why field education is valuable. However, quantitative findings imply that some of these potential outcomes are valued more highly than others (Tables 2, 3, and 4).

A large majority (89.5%) of participants agreed that fieldwork *in general* should be a required part of undergraduate programs (Table 2). Code counts (expressed here as % of responses assigned to a theme or sub-theme) indicate that participants perceive a positive impact on knowledge and skills, enabling learners to put theory into practice (sub-theme 2d, 35%) and enhancing specific geoscience knowledge, skills, and problem-solving (sub-theme 2b, 18.3%). On the negative side, 5% indicated that fieldwork may not be needed for all potential careers or disciplines in the geosciences (sub-theme 5d). Using a scale from zero (not important) to 10 (absolutely essential), participants assigned a mean score of 9.6 to the value of field experience. They expressed strong agreement that fieldwork should be required in undergraduate education, thus corroborating the qualitative findings, and that knowledge and skills learned in the field could not be learned in the classroom (Table 3). They also agreed that professional geoscientists should be able to solve problems in the field, while disagreeing with the notion that geoscientific expertise can be gained without fieldwork experience (Table 3).

A smaller, through still strong majority (79.4%), agreed that a geologic *field methods* course or camp should be required in undergraduate programs (Table 2). These experiences are most valued for enhancing geologic knowledge and skills (sub-theme 2b, 24.1%), although a minority identified expense as an issue (sub-theme 5a, 4.2%). Participants assigned a mean score of 8.4 to the value of participating in a field camp or residential fieldwork, while the three most important learning outcomes of residential fieldwork were identified as improvement in critical thinking and problem-solving skills, enhanced understanding of fundamental geoscience concepts, and gaining proficiency in field skills (Table 4).

In summary, study participants valued undergraduate geoscience fieldwork for its perceived effectiveness in developing knowledge and skills (cognitive and practical) through direct engagement with geologic phenomena. Consistent with previous investigations (e.g., Boyle et al., 2007; Stokes and Boyle, 2009), affective responses were viewed as important to the learning process but did not emerge as valuable. Overall, the study population expressed strong support for the requirement of fieldwork per se in undergraduate education but slightly less support for residential field courses or camps.

THE PERCEIVED VALUE OF BEDROCK MAPPING

Findings relating to bedrock mapping are interesting and somewhat contradictory. Only 36.5% of respondents agreed that a mapping course should be required. Despite the roughly equal proportions of positive, negative, and mixed responses to this question (Table 2), a higher proportion of negative themes to positive themes emerged from the data. Respondents were predominantly concerned by the specialized nature of bedrock mapping (sub-theme 5d, 27.9%), although the positive impacts on knowledge and skills were again recognized (sub-theme 2b, 18.1%). Participants held reasonably positive perceptions about the ability to map bedrock, awarding it a mean value score of 6.7, and expressed general agreement that training in bedrock mapping should be provided in undergraduate programs (Table 3). While recognizing that the process can help students to understand how geologic maps are created, they were neutral on whether training

Table 3. Responses to survey items using a 5-point Likert scale*

Survey item	All respondents (n = 172)	Learners (n = 93)	Instructors (n = 66)	Industry professionals (n = 25)
Fieldwork experience should be compulsory for all geoscience majors/students on undergraduate geoscience programs.†	5 (5)	4 (5)	5 (5)	5 (5)
The knowledge and skills gained through fieldwork cannot be learned in the classroom.	5 (5)	5 (5)	5 (5)	4 (4)
All professional geoscientists should know how to solve problems in the field.	4 (5)	4 (5)	4 (5)	4 (4)
It is possible to become an expert geoscientist without fieldwork experience.	2 (2)	2 (2)	2 (2)	2 (2)
The best geologists are those who have seen the most rocks.	3 (2)	3 (2)	3 (3)	3 (3)
All colleges and universities should provide some kind of training in bedrock mapping.	4 (4)	4 (4)	4 (4)	3 (3)
Bedrock mapping is what geoscience is all about.	2 (2)	2 (2)	2 (1)	2 (2)
No matter what career path a student takes, s/he should have training in bedrock mapping.	3 (3)	3 (3)	3 (3)	3 (3)
Is it important for students to learn bedrock mapping so that they understand the process by which geologic maps are created.	4 (4)	4 (4)	4 (4)	4 (4)
The process of making a geologic map (i.e., learning the skills and knowledge required to make the map) is more important than the outcome (i.e., producing a good map).§	4 (4)	4 (4)	4 (4)	3 (4)
Bedrock mapping is less important today than it was 20 years ago.	3 (2)	3 (2)	2 (2)	2 (1)

* Likert scale: 1 = strongly disagree; 5 = strongly agree. Data are reported as median (mode) value.

† Results of Kruskall-Wallace test indicate that a significant difference between groups exists (p = 0.046). Results of Mann-Whitney U test indicate a significant difference between learners and industry professionals (p = 0.037).

§ Results of Kruskall-Wallace test indicate that a significant difference between groups exists (p = 0.044). Results of Mann-Whitney U test indicate a significant difference between both learners and industry professionals (p = 0.028) and instructor and industry professionals (p = 0.014).

Table 4. Percentage of participants choosing each statement as one of the three most important learning outcomes from a residential field course or camp

Learning outcome	All respondents (n = 172)	Learners (n = 93)	Instructors (n = 66)	Industry professionals (n = 25)
Better understanding of fundamental geoscience concepts	13.8	13.7	13.9	21.5
Enhance critical thinking and problem-solving skills	18.1	18.8	19.4	15.4
Develop social and professional relationships with peers and instructors*	3.3	3.7	1.7	0.0
Increased confidence in working with “real” data and problems	12.3	12.2	11.7	10.8
Better preparation for a career in the geosciences	4.9	5.2	4.4	1.5
Better appreciation for how geosciences applies to the real world	6.8	7.4	5.0	9.2
Integrating knowledge from a range of courses	8.0	8.1	10.0	6.2
Developing geoscientific expertise	2.3	1.8	2.2	3.1
Proficiency in field skills	12.6	11.8	13.9	10.8
Proficiency in generic skills	6.0	5.9	5.6	6.2
Developing expert-like behavior	4.9	5.5	3.9	4.6
Learning how geoscientists think and reason	6.8	5.9	7.8	10.8
Other (Learning about one’s abilities, skills, and weaknesses)	0.2	0.0	0.6	0.0

*Results of Pearson chi-square test for independence indicate a statistically significant difference between groups for this item (p = 0.029).

in bedrock mapping was necessary for all career paths and disagreed that mapping is a fundamental component of geoscience (Table 3).

In summary, the data indicate a perception that bedrock mapping has some value and courses should be available, but not required, for all undergraduates. Mapping is perceived to enhance knowledge and skills and to help students understand how maps are created; however, it should only be required when in the interest of the student.

PERCEPTIONS OF VALUE ACROSS GROUPS

Overall, we found perceptions across the three participant groups to be highly consistent. No statistically significant differences were found in the levels of agreement with the three open-ended questions across categories of participants (Table 2). Industry professionals expressed greatest support for undergraduate residential field courses or camps (Table 2) and were more likely to consider physical interaction with geoscience phenomena as critical to undergraduate learning (sub-theme 2e, 20.6%). Although these data were not statistically significant ($p = 0.054$–0.058), the Likert data (Table 3) revealed significantly greater support for undergraduate residential field courses or camps among industry professionals than among learners ($p = 0.037$).

In summary, our findings indicate broad agreement among the participant groups concerning the value of undergraduate field education, with the following interesting exceptions: (1) the favoring of compulsory residential field camps and courses by industry professionals (Table 3); (2) the valuing of social interactions in field courses by learners (Table 4); and (3) the valuing of creating good maps by industry professionals (Table 4).

STRENGTHS, LIMITATIONS, AND FUTURE WORK

This research makes an important contribution to the existing literature on fieldwork pedagogy by enabling values relating to field education to emerge directly from the population under study, rather than enforcing a preexisting framework. The triangulation process used with data analysis and interpretation (GSA Supplemental Data, Part A [see footnote 1]) lends credibility to the findings by demonstrating convergence between the emergent coding and quantitative data.

Some significant limitations to this study need to be recognized. First, participants were drawn from a convenience sample of geoscientists within a single professional organization with a predominantly North American membership. Second, the sample is small and non-representative. The American Geological Institute reports ~24,000 undergraduate geoscience majors and 9,000 graduate students at U.S. institutions in 2011 (Gonzales and Keane, 2011). The U.S. Bureau of Labor Statistics (2013) reports that ~76% of roughly 35,000 employed geoscientists work in various industries with the remainder in state or federal government, and ~13,000 work as post-secondary faculty in atmospheric, earth, ocean, marine, and space sciences. Even with these rough estimates, we have clearly under-sampled industry professionals, particularly those who work in non-government positions.

This issue of sample representativeness is more likely to impact the quantitative analysis than the qualitative coding. Themes describing the value of fieldwork bear a striking resemblance to the outcomes of field education derived from “practitioners’ wisdom” (Mogk and Goodwin, 2012) and analysis of selected field course syllabi (Pyle, 2009). Thus, we argue that the emergent categories or values of field education are robust, but that the quantitative analysis should be interpreted with caution. The next step is therefore to extend this survey with a larger and more representative international population, in order to achieve a more informed perspective on the value of field education.

CONCLUSIONS AND RECOMMENDATIONS

Geoscience field education is rapidly approaching a critical crossroads. With 89.5% agreement that fieldwork should be a fundamental requirement for undergraduate geoscience programs, this study empirically supports the general perception among our community that “fieldwork is good” (Boyle et al., 2007). However, this perception alone is not enough to withstand the increasing pressures of expense, liability, and accountability related to taking students into the field. Considering our findings in light of the current state of field education, we recommend the following courses of action. First, there is a clear need for critical and open discussion between academia and industry about the role of bedrock mapping in field education. This dialogue must extend across the international geoscience community to ensure that the diversity of opinions over how to best use field education to prepare students for the wide range of geoscience professional opportunities are properly debated and addressed. Next, the observed discrepancies between learners, instructors, and industry professionals merit further investigation. Again, this reflects the necessity for robust dialogue between academia and industry; ideally, students’ educational field experiences should prepare them for the workforce, and thus the learning goals of field education and employer needs should be well-aligned. Next, academic institutions need the vocal support of industry to ensure that field education continues to have a place in resource-strapped undergraduate programs. Finally, we call on the geoscience education research community to further investigate the actual impacts and benefits of field education, in order to test empirically whether the value that our professional community perceives in field education is justified.

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