Social Learning Theories—An Important Design Consideration for Geoscience Fieldwork

M. J. Streule[1,a] and L. E. Craig[1]

ABSTRACT

The nature of field trips in geoscience lends them to the application of social learning theories for three key reasons. First, they provide opportunity for meaningful practical experience and promote effective learning afforded by no other educational vehicle in the subject. Second, they are integral for students creating a strong but changing sense of identity from student, to geoscience student, to practicing professional geoscientist. Third, they help students to develop and build their own communities of practice within the field trips akin to the professional communities of practice they may be expected to contribute to, and pursue inbound trajectories into, in the future. Furthermore field trips encourage students to actively engage and initiate trajectories within the wider disciplinary geological community of practice. The building and effectiveness of communities of practice are important because the nature of geoscience as an integrative subject lends itself to relying on such communities. Therefore, the designers of field-trip programs should be aware of this social learning theory and ensure that working within communities of practice is integral to the activities they design. In so doing, we will produce graduates in the subject that will serve the requirements of industry and academia alike, in addition to other graduate careers. Students that most successfully participate in field trips are characterized by independence in their learning and increasing self-efficacy.
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Key words: field trips, social learning, undergraduate, community of practice

INTRODUCTION

"I have learnt more this fieldtrip than I did in the all my lecture courses last term"—This is a quote from an Imperial College student towards the end of their recent geoscience field trip. It is not an isolated quote, but one to which most geoscience educators can relate. Field trips provide an opportunity for unique and effective learning that can be afforded by no other method in geoscience. Quantitative research by Elkins and Elkins (2007) confirmed that field trips improve understanding of geoscience concepts more that classroom-based courses, but they did not explore the reasons why. A typical geoscience field trip of 1 week or more duration will combine both directed and independent learning exercises and involve both individual and small group work.

Research by Boyle et al. (2007) confirmed that students' perceptions of field trips were that they were highly effective. However, the research to date does not offer much to explain *why* field trips offer such a valuable learning experience compared to other educational experiences that may be offered during a typical undergraduate geoscience degree. Petcovic et al. (2014) undertook a survey across students, educators, and professionals that identified cognitive gains as the main benefit of fieldwork. Stokes and Boyle (2009) studied the link between affective responses and learning outcomes and highlighted the importance of social interactions, but they did not frame fieldwork within any social theory. A thematic paper by Mogk and Goodwin (2012) highlighted a range of cognitive, learning, and social aspects that are relevant to fieldwork, including the concept of a community of practice, but they did not perform a thorough analysis. It is therefore the aim of this commentary to analyze field trips in the context of social theories of learning to try to better understand why field trips are widely perceived as such valuable educational experiences in geoscience.

Lave (1996, 149) argued that considering "learning as a social collective rather than an individual psychological phenomenon" offers the only way to better understand learning. Field trips are socially intensive experiences for both students and lecturers alike, activities are always undertaken in the company of others, there is a high number of contact hours between student and lecturer, teaching assistants can be used to bridge gaps between student and lecturer social (and academic) perspectives, and geological discussion of geoscience is encouraged amongst students—these are just some of the reasons why a social theory of learning is a useful theoretical framework in which to better understand the field-trip learning experience. Wenger (1998) also asserted that we are profoundly "social beings," and therefore this aspect of our very nature must also be central when considering our learning. As a result of presenting field trips in this theoretical framework, we will demonstrate *why* field trips represent an educational experience that is a fundamental necessity for successful undergraduate geoscience education that can be substituted in no other effective way. Furthermore, we will examine *how* students navigate this social framework through the course of their undergraduate education and develop as learners in the process.

SOCIAL THEORIES OF LEARNING AND FIELD TRIPS: MEANINGFUL PRACTICAL EXPERIENCE

To understand the difference in educational experience that a field trip provides, the theoretical framework of social

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[1]Department of Earth Science and Engineering, Royal School of Mines, Imperial College, London, SW7 2AZ, United Kingdom
[a]Author to whom correspondence should be addressed. Electronic mail: m.streule@imperial.ac.uk

learning needs to be explored. Dewey (1903) was one of the first educationalists to identify the complexity of learning, i.e., that it is a social and interactive process and that providing students with a limited set of vocational skills in a confined educational context offered a great disservice to them and their minds. The importance of successful social interaction, which was a prerequisite for any cognitive development to take place in learning, was identified by Vygotsky (1980), but this was written largely in the context of child development. From the adult perspective, as hugely complex social beings, learning by direct experience (Bandura and McClelland, 1977) is considered to be a fundamental part of the learning process, and this is best done in a system of social learning whereby the direct experience is undertaken in the company of others, and by the observation of others. Field trips are typically designed to promote self-directed geological enquiry—practical problems are presented to students that need to be solved as a group. Students pursue courses of action that are at times successful and at times unsuccessful; it is the practical experience of success and failure that will be most informative to learning as a social being. This provides the strongest positive reinforcement possible to the pursuit of successful courses of action in future practice.

It is not just successful courses of action in geological enquiry that can be learned on field trips. The more fundamental content of an undergraduate geoscience course can also be effectively learned on field trips. For example, students may be shown some deformed rocks in a series of photos during a lecture course, and they would to some extent learn about them from that experience. However, on a field trip, they are able to see them for themselves, to look at them from whichever angle they want, from close-up and from far away. They have much more of a *direct* experience and can interact directly with academic content within its relevant context. Such directness of experience is key to the experiential learning theory of Kolb (1984), which emphasized the *process* of learning as extremely important, not just the outcomes of that learning. Again, put another way, it is the practical experience that is so important. While Kolb only considered learning from the perspective of experience from individual enterprise, combining this with the social perspective of Bandura serves to highlight the importance of direct experience, but that it must be undertaken in a social setting for effective learning. It is not necessarily what a student knows that is important; it is more how the student came about knowing it, and in what social setting, that represents the quality of education. Learning as a result of practice, by doing, thinking, and speaking as a geoscientist would do, and not as a result of the final outcome, is a key component of a more encompassing social theory of learning proposed by Wenger (1998).

Often on a field trip we have been asked by a student if something is right or wrong. We do not answer the question with a yes or a no; we ask what observations, processes, or investigations the student has gone through to yield their answer. Highlighting correct (or incorrect) practice here will then answer their original question for them—correct practice will yield the right answer. Did the student also discuss their answer with their colleagues? Did that help to refine their answer? Can we discuss and refine it together now? Such a discussion can also emphasize the value of social interaction from the perspective of geoscientist to geoscientist and place less emphasis on the student–teacher perspective. Such a strategy emphasizes the value and importance of learning based on practical experience, framed in an appropriate social context on a field trip.

The social theory of learning proposed by Wenger (1998) also emphasized the importance of giving "meaning" to learning, that is, to make sense of learning within the world around us. As fundamentally inquisitive beings (Kneller, 1971), if we are placed directly in the real-world situations, meaning will be naturally generated in our learning experiences. By the very nature of the field trip, being *in* the world around us, meaning is intrinsically built into the learning. Learning of meaning a result of "experience" was distinguished by Wenger (1998) from learning of practice as a result of "doing" as two separate components in his social theory. In the context of geoscience, field trips constantly serve to provide experience *and* doing at the same time, and as a result, we see that the learning of practice and meaning are intrinsically interlinked and inseparable products of a field trip. Field trips therefore provide a unique opportunity for meaningful practical experience to be undertaken to yield effective learning.

BUILDING AND CHANGING IDENTITIES ON FIELD TRIPS

Wenger's (1998) social theory of learning also highlights the concept of identity—who we are and who we become in the process of learning—as being an important consideration in the effectiveness of learning. Field trips are a powerful tool in developing identities of students as *geoscience* students, and as a result of this, they are powerful tools for effective learning. More importantly, field trips also provide an opportunity for students to begin to operate more as a "real" geoscience graduate entering the geoscience profession. This change is characterized by students engaging in the practical experiences that emphasize the necessity of coworking amongst fellow geoscientists, with less emphasis on the teacher–student relationship. They begin to use the language of professional geoscientists and undertake the activities a professional geoscientist would be tasked to do, albeit in a more structured environment. Field trips provide an opportunity to create working communities that closely resemble the professional communities that students will enter into in the future, as well as enabling students to begin to enter the wider disciplinary community of geoscientists in general. As a result, their successful completion should be a necessity to graduate with a good degree in the subject because field trips are an integral part of the process of changing identity as suggested by Mogk and Goodwin (2012). Well-designed field trips should therefore actively endeavor to take students from acting as students and move them towards acting as *geoscience* students and then in turn as professional geoscientists. The participants of the field trip should not be afraid; indeed, they should be encouraged to feel their identity changing, and field-trip leaders should design tasks to promote these identity changes.

A student, recently out of high school and entering higher education may traditionally see learning as a process by which knowledge is transferred from the teacher to the student. Such a student would have the perception that a surface approach to learning—defined by Ramsden (1992) as

focused on the memorization of factual, "known" information and recall of that information for exams—is most likely to lead to academic success. This is a relatively narrow cognitive viewpoint (as described in Wenger, 1987) that does not consider other important aspects of learning. Crawford et al. (1994) found strong empirical evidence of such a conception in students entering university to study mathematics, and from our experience, a student entering university to study any of the sciences is likely to have a similar conception, partly as a result of their likely similar high school subject choices and experiences. However, as the students become more established at university, the processes of problem solving and integration of knowledge become more important, rather than assimilation of content, and a deep approach to learning should be adopted (as defined by Ramsden, 1992). Even more so, as students progress through university, they increasingly engage with knowledge as possibility and probability and not de facto knowledge (Moore et al., 2006), and therefore learning becomes more about enquiry into this realm of the unknown. Such a change in their perception of, and approach to, their learning represents a change in identity for the student—they will no longer see themselves as a school pupil but instead see themselves as a university student as a result of a change in their very perception of learning.

Field trips can play a very important and powerful role in changing this important influence upon a student's identity. They intrinsically promote this change because, typically, assessment of field trips for summative purposes is strongly focused on the assessment of geological field procedures and methods of enquiry (e.g., note-making, map drawing, geological field measurements) along with the integration of observation with theory in an ontological manner characteristic of geoscience (Brodaric and Gahegan, 2001). The final "answer" in itself should not be the focus of assessment; there is often not a "definitive" answer anyway, but rather it is the robustness and quality of their evidence that are important. Effective assessment of field trips should therefore focus on geological evidence and geological feasibility of a students' answer. This will place assessment emphasis on the engagement of the student in the meaningful practical experiences of geological fieldwork. However, field trips have the opportunity to go one stage further, particularly for capstone courses taken by geoscience majors. They have the opportunity to promote the change in identity from geoscience student to professional graduate geoscientist. Such a change in identity is promoted by the increasing *independence* of the work that is pursued on field courses. As university students progress towards a professional identity, they will distance themselves from having and indeed wanting a lecturer overseeing and guiding their work. They will become more independent in thought and more self-motivated in their work as they gain confidence. They will become more aware of the standards required, and they will begin to assimilate the identity of a graduate of the subject. Well-designed field trips enable students the gain confidence (Stokes and Boyle, 2009) to start making this identity change, which is much more difficult to engineer in an on-campus lecture-based setting. This is one of the reasons why many graduate employers value geoscience graduates with extensive field-trip experience—they know they are employing graduates that have, or, at the very least, are close to having the professional identity of a graduate geoscientist that they expect when they start work, and so they will not have to spend extensive time with induction programs to promote this identity change or instill a new framework of expected standards.

There is one other, perhaps more simple aspect of geoscience field trips that contributes to promote identity learning that should not be overlooked. Geoscience field trips are pretty much unique amongst the sciences in their nature; they typical visit relatively remote places, require a unique set of equipment, and require extended periods away from university. Simply participating in field trips gives students a unique sense of identity as geoscience students. Field trips are to a geoscience student what the hospital is to a medical student. They are unique locations of learning that inherently promote and develop the student's identity, which is so important for effective field-trip learning.

FIELD TRIPS DEVELOP A COMMUNITY OF PRACTICE

Geoscience, as a subject, requires a truly integrative approach. There are very few fundamental principles of geoscience, compared to, say, physics, where there are many, such as gravity and the speed of light. However, where geoscience differs, and where geoscience excels, is in the *application* of mathematics and the sciences to the study of Earth. Therefore, a student of the subject has to be integrative in their approach—they will need to utilize many different aspects of their scientific education in order to gain a better understanding. As they progress through the subject to higher levels, they will find themselves unable to be truly integrative across all of the sciences' application to geoscience, and they will therefore need to begin specializing. As a consequence of this, to solve the more complex problems presented to them in geoscience, they will often have to go back to the idea that geoscience is a truly integrative subject, and thus draw on the expertise of others as well as of themselves to solve the problems and develop better understanding. Communication skills with their colleagues will therefore be an important aspect, indeed requirement, for students' success on field trips. Field trips may be the first time during their university career that they have to truly work collaboratively with their peers and to value and use the expertise of others. In so doing, students will have to develop communication skills and strategies for collaborative working, which are necessary traits of a successful graduate geoscientist.

The integration of academic expertise and problem-solving skills with broader communication skills within an individual relates to the model of a "versatilist" as described by Donofrio et al. (2009). In such an individual, academic expertise of the individual and coworkers is used to drill down to solve the problem. Overarching communication skills are then required to bring the solution of the problem together. Donofrio et al. (2009) used the ever-increasing body of knowledge in the scientific disciplines as indication for the need of increasingly versatile individuals in the future. Given the nature of geoscience as a broad and interdisciplinary subject, the need for versatile graduates particularly in geoscience therefore seems obvious. In the social context of communities undertaking shared enterprise, it is the overarching communication skills that act to form

cohesion within the community, which, when combined with the academic expertise of individuals within the community, generates greater effectiveness of that community.

So, if the solving of geological problems requires an approach that will need to draw on the expertise of others, then social interaction will be needed, or as Wenger (1998) puts it, a community of practice will need to be developed. Wenger et al. (2002, 4) defined communities of practice as "groups of people that share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting in an ongoing basis." A community of practice is an integral aspect of the social theory of learning. This is where the field trips become so important within an undergraduate body of geoscience students. Simply labeling students as "geoscience undergraduates" and placing them in a lecture room to some extent will create a community of practice. However, it is a relatively artificially created community, and the scope for "interacting in an ongoing basis" will be limited. However, field trips are socially intensive educational experiences, and so an opportunity to develop the group of students into a true, interacting community (of practice) is encountered with the same shared aim of learning and developing their skills and abilities in geoscience. The community of students is in one another's company 24 h per day, and challenging geological problems set in the field will yield discussion among students, and ultimately accomplish the aim of the field trip, which is to deepen the knowledge and expertise of the students. Shared engagement in a mutual endeavor is a key aspect of developing a community of practice. Put more practically, field-trip leaders should not shy away from the "we are all in this (geological mess!) together" type of message to students. Field trips therefore provide an opportunity for students to build and develop communities of practice that closely resemble those that they may be expected to build and develop in the workplace when beginning careers after graduation (Wenger et al., 2002). While the shared aims and enterprises may slightly differ when working as a graduate geoscientist, in many other respects, the communities of practice would share many similarities; for example, the community will be composed of active practitioners, and the community will share information and provide mutual support within the community.

The above analysis is a little simplified though—it relies on all members of the community being mutually useful to one another, and that social interaction is a straightforward and natural process for all within that community. The reality is that some students find the social interaction more challenging, and those students can find themselves on the periphery of the community of practice and not as "useful" members of that community. They are not incorporated into discussion as much and do not have their opinions asked of them as frequently. How does a social theory of learning help field-trip leaders ensure that such students still make good progress and "deepen their knowledge and expertise" as the community as a whole is striving to do? Lave and Wenger (1999) identified that people engage with a community of practice through "legitimate peripheral participation." The key here is that the participation is "legitimate." At the very least, legitimate peripheral participation helps to create a sense of identity, as discussed earlier, that is a key aspect for learning to take place. Such a consideration therefore creates legitimacy to any participation on a field trip. Legitimate peripheral participation in the community created by a field trip may also be characterized by the observation of tasks taking greater precedence over the undertaking of tasks. In such a scenario, there would be a stronger emphasis on being guided, and the learner would be in a "zone of proximal development" (Vygotsky, 1980). Importantly, though, however a student engages with the community of practice, the learning is very much still experiential—it is "situated" learning, and as such, even observation serves as meaningful practical experience. Situated learning is an important process in beginning to work in a community of practice through "legitimate peripheral participation" (Lave and Wenger, 1999), where the content and context of the work are representative of the community of practice. Field-trip leaders should be aware that so long as even some peripheral participation in some manner is being made with the community created on the field trip, then effective situated learning will take place.

Students that find themselves in legitimate peripheral participation, however meaningful that experience is and however identity forming that may be, can be drawn towards the center of the community of practice by carefully designed tasks that directly require coworking; i.e., mutual engagement in a joint enterprise is key to forming the community. Wenger (1998) defined this as being an inbound trajectory, where novices in a community aspire to become fully practicing participants. In a sense, a field trip generates a completely novice community of practice, with the expected outcome that the entire community will pursue an inbound trajectory, and with that comes effective learning. Promoting an inbound trajectory could, for example, be achieved by creating tasks that require working in pairs, which will require social collaboration and shared enterprise within that coworking pair—in essence a micro-community of practice. In turn, that coworking pair is part of the wider community of practice encompassed by all the participants of a field trip, and the community as a whole also has a mutual goal—that of learning and developing expertise in the subject and aspiring to the identity of a professional geoscientist. The field-trip environment therefore creates a simulated community of practice in which the aim from a teachers' point of view is that everyone is on an inbound trajectory. The necessity of the student to successfully negotiate inbound trajectories through a community of practice will be akin to the requirements of them when they enter new communities of practice after graduation.

Graduation will also mark their entry into a wider disciplinary community of practice—that of geoscientists—in which fieldwork skills and experience are highly valued (Petcovic et al., 2014). In a sense, one of the shared aims of the community of practice created on a field trip is to progress towards another, broader disciplinary community of practice. However, graduates may not necessarily pursue inbound trajectories in this broader disciplinary community for one reason or another. Wenger (1998) offered a description of alternative trajectories that could be pursued by individuals graduating from geoscience degrees. This is particularly the case where geoscience graduates enter into a field with only a tangential relevance to geoscience. As a result, they may pursue a peripheral trajectory, where access to the geological community and its practice is still maintained, but greater participation is not necessary; for

example, a graduate pursuing a career in mineral finance may adopt this trajectory. A boundary trajectory may be adopted by a student looking to link communities of practice; perhaps individuals with particularly good communication skills would be most effective at bridging communities. Finally, students may pursue an outbound trajectory; the students' initial peripheral entry into the community of practice of graduate geoscientists was sufficient for the student to then enable a new trajectory into a different community of practice, and formation of a new identity to be pursued. One such an example would be a student entering into a graduate recruitment scheme in the banking sector, undertaking work completely unrelated to geoscience, and which required a "good degree in any subject" for entry.

Therefore, the extent to which students on a field trip spend time in legitimate peripheral participation of the simulated community practice is not important. The social theories of learning and, in particular, the concept of communities of practice serve to help us understand and appreciate the value and uniqueness of the experiences that field trips offer to all students irrespective of their level of participation. These methods also urge field-trip leaders to design tasks that help to build and develop the community of practice throughout the field trip, by equipping students with the skills to pursue inbound trajectories within that community. Such experiences are necessary, valuable, and useful, as similar inbound trajectories will inevitably need to be pursued in a graduates' future employment. The implicit training in navigating communities of practice that field trips offer therefore helps to explain their immense value in geoscience education and why geoscience graduates are sought after by a wide range of employers.

THE FUNDAMENTAL NECESSITY OF FIELD TRIPS

We have demonstrated that social theories of learning are useful in helping to understand the unique and valuable experience that field-trip learning offers. It is not simply that many exercises on field trips involve group work and actively promote developing the community of practice within the field trip, but it is more an inherent social property of human beings: Put 40 students on a cold, windy hillside, ask them to tackle a geological problem, or undertake some geological investigation, even individually, and social interaction will inevitably follow. Those students that participate in this social interaction, formulate the greatest meaning for their practical experiences, migrate on an inbound trajectory towards the center of a community of practice, and are comfortable with changing their identity from student to geoscientist most effectively will, if that broad underpinning scientific knowledge is there, succeed to the highest level. Ultimately, field trips provide a close representation of life as a professional geoscientist—the navigation into and development of communities of practice that occur through collective purpose, shared endeavor, and interrelated practical experiences represent exactly the type of continued professional learning that would be expected of a graduate geoscientist. This socially situated learning and the subsequent community of practice developed on the field trip provide perfect training for the type of environment a successful professional geoscientist would likely encounter. The skills developed are also useful to many other professional areas into which graduates of the subject may enter. Therefore, that is why every field-trip leader, drawing on the feedback and experiences of students, values fieldwork so highly in undergraduate geoscience education—it is indeed a necessity for successful undergraduate geoscience education if our graduates are to be highly employable and sought after. Field trips therefore need to be an integral part of successfully "passing out" of a geoscience degree because they provide the socially situated learning experiences so necessary for effective learning and for a student's career beyond university.

TOWARDS A GREATER GOAL: DEVELOPING THE INDEPENDENT LEARNER

While the concept of communities of practice offers a rationale for understanding the effectiveness and necessity of field trips in a sociotheoretical framework, Lave and Wenger's communities of practice only offer a descriptive overview of their framework; there is very little discussion on what actually happens to the learner as knowledge is developed. It is therefore also valuable to think a little more deeply about the students that are involved in this learning process, and how the process may change those students. This in part builds on the ideas of the changes in identity discussed earlier, and development of a community of practice. However what cognitive changes occur during the change in identity? What changes occur to the student as a student moves from the periphery of a community of practice (however legitimate that participation was) towards full integration on an inbound trajectory within that community?

Much of what a field trip is often designed to do, and what is expected of graduates of the subject, is an increasing independence of thought. Unfortunately, there appears to be little understanding of what independent learners actually are (McKendry and Boyd, 2012), but in the context of fieldwork, we would enlist the definition of Broad (2006, 121), that students becoming independent learners would enable them to "learn for themselves and in turn empower them in their learning whatever the context." In trying to define an independent learner, parallels are drawn to the definition of a learner's self-efficacy: "the belief in one's effectiveness in performing specific tasks" (Zimmerman and Cleary, 2006, 145). Research demonstrates a correlation between self-efficacy and independent learning (Zimmerman et al., 1992).

So while social theories of learning help us to describe and understand how and why effective learning environments are created, how do we manipulate the learning on field trips even more to increase the cognitive independence and self-efficacy of the learner? Billett (1996) made some effort to bridge the gap between Lave and Wenger's social theory of learning and cognitive theories of learning. In cognitive theories, the learner is considered an entity in their own right, underpinned by a "unitary mind" (Anderson, 1983). Billett (1996) identified that a number of complementary concepts bridge across the social theory of learning and cognitive concepts of knowledge. Navigation from social to cognitive theories of learning is best undertaken with a consideration of what the transition from a relative novice to a relative expert looks like within the two theories, as this

transition is one of the aims of undergraduate education. The social theory of learning identifies the transition to expertise as movement towards full participation concomitant with development of identity within a community of practice—an inbound trajectory. Cognitive concepts of knowledge, however, identify the ability to perform nonroutine tasks, or navigate an impasse using their own self-organized knowledge as a hallmark of an expert (Hoffman, 1998).

Within the context of a field trip, there is a key concept behind the design of tasks that links these two ideas, that is, problem solving in a social environment. To solve problems in a social environment requires (assuming they are sufficiently demanding) both cognitive processes to occur within the individual and social interaction with other individuals. Therefore, the ability to solve ever more complex geological problems, representative of the transition from novice to expert, involves advancing cognitive ability while navigating a sociocultural environment and progressing in a community of practice. Those that are most successful in this endeavor will be, by the very nature of field trips and the independent work that they involve, those that navigate this process with greatest independence of thought and learning, as this will allow greatest cognitive advancement.

CONCLUDING REMARKS

This description of field trips in a social framework helps us to better understand their value and necessity within the context of a geoscience degree from the perspective of a field-trip leader or course designer. Understanding how a student navigates through this social framework, by developing greater independence of thought and becoming more versatile, allows us to better understand what is so educationally important in field trips from the student perspective.

A better understanding of the value and necessity of field trips also helps to identify and promote their good design and planning and their most effective incorporation into the wider curriculum of an undergraduate degree. If students are expected to navigate the community of practice generated on a field trip with an inbound trajectory, a changing identity, and meaningful practical experiences, they will need to be trained with the required base of knowledge in the curriculum, as well as the communication and collaborative coworking skills. Put in another way, the individual's skills need to be deepened (academic knowledge) *and* broadened (communication skills) prior to the field trip. If students do not come back from a field trip with a positive experience, the too-often quick conclusion is that the academic content was too hard or too easy. However, it may also be that the students had insufficient social skills (in the context of field trips) to navigate the community of practice effectively. It is often assumed that fieldwork is a positive experience for all, but detailed research suggests that this is often not universally the case (Stokes and Boyle, 2009; Petcovic et al., 2014). Unsuccessful students may find themselves on outbound, peripheral, or boundary trajectories, rather that the intended inbound trajectory. Setting an expectation and generating awareness among students that social and communication skills are key requirements for field trips, in addition to traditional academic ability and knowledge, will go some way to solving many problems that can culminate in nonparticipation.

As well as the academic lectures, field trips should also be supported by prior training in skills so that the students are better equipped to build, develop, and navigate the community of practice set up on a field trip. Orion and Hofstein (1994) proposed that pre-fieldwork training to increase "familiarity of the learning setting" of field trips would subsequently improve attainment during the field trip. Marques et al. (2003) identified collaborative group-based work as important preparatory exercises, highlighting the social aspects of learning. An awareness and understanding of social learning theories by designers of field programs and their pre-fieldwork training are therefore important to ensure high attainment and an environment on a field trip where all students have a positive experience. As well as preparing students for inbound trajectories in a community of practice, field trips also set students on a trajectory into the wider disciplinary geological community of practice. A student's goals, whether they are entering academia, industry, or pursuing further study, will define what type of trajectory this is, but it is important that both field-trip leaders and geoscience curriculum designers are aware of the importance, value, and necessity of field trips from a social learning perspective.

REFERENCES

Anderson, J. 1983. The architecture of cognition. Mahwah, NJ: Lawrence Erlbaum Associates.

Bandura, A., and McClelland, D.C. 1977. Social learning theory. New York: General Learning Press.

Billett, S. 1996. Situated learning: Bridging sociocultural and cognitive theorising. *Learning and Instruction,* 6:263–280.

Boyle, A., Maguire, S., Martin, A., Milsom, C., Nash, R., Rawlinson, S., Turner, A., Wurthmann, S., and Conchie, S. 2007. Fieldwork is good: The student perception and the affective domain. *Journal of Geography in Higher Education,* 31:299–317.

Broad, J. 2006. Interpretations of independent learning in further education. *Journal of Further and Higher Education,* 30:119–143.

Brodaric, B., and Gahegan, M. 2001. Learning geoscience categories in situ: Implications for geographic knowledge representation. *In Proceedings of the 9th ACM International Symposium on Advances in Geographic Information Systems*. ACM Press, New York. p. 130–135.

Crawford, K., Gordon, S., Nicholas, J., and Prosser, M. 1994. Conceptions of mathematics and how it is learned: The perspectives of students entering university. *Learning and Instruction,* 4:331–345.

Dewey, J. 1903. Democracy in education. *The Elementary School Teacher,* 4(4):193–204.

Donofrio, N., Spohrer, J., and Zadeh, H. S. 2009. Research-driven medical education and practice: A case for T-shaped professional. *MJA Viewpoint* [Online]. Available at http://www.ceri.msu.edu/wp-content/uploads/2010/06/A-Case-for-T-Shaped-Professionals-20090907-Hossein.pdf (accessed 1 July 2014).

Elkins, J.T., and Elkins, N.M. 2007. Teaching geology in the field: Significant geoscience concept gains in entirely field-based introductory geology courses. *Journal of Geoscience Education,* 55(2):126–132.

Hoffman, R.R. 1998. How can expertise be defined? Implications of research from cognitive psychology. *In* Williams, R., Faulkner, W., and Fleck, J., eds., Exploring expertise. New York: Macmillan, p. 81–100.

Kneller, G.F. 1971. Introduction to the philosophy of education. New York: Wiley.

Kolb, D.A. 1984. Experiential learning: Experience as the source of learning and development. Englewood Cliffs, NJ: Prentice-Hall.

Lave, J. 1996. Teaching, as learning, in practice. *Mind, Culture, and Activity*, 3(3):149–164.

Lave, J., and Wenger, E. 1999. Legitimate peripheral participation. *In* Murphy, P., ed., Learners, learning and assessment. London: The Open University, p. 83–89.

Marques, L., Praia, J., and Kempa R. 2003. A study of students' perceptions of the organisation and effectiveness of fieldwork in Earth Sciences education. *Research in Science and Technological Education,* 21(2):265–278.

Mogk, D.W., and Goodwin, C. 2012. Learning in the field: Synthesis of research on thinking and learning in the geosciences. *In* Kastens, K.A., and Manduca, C.A., eds., Earth and mind II: A synthesis of research on thinking and learning in the geosciences. Boulder, CO: Geological Society of America, Special Paper 486, p. 131–163.

Moore, R., Arnot, M., Beck, J., and Daniels, H., eds. 2006. Knowledge, power and educational reform: Applying the sociology of Basil Bernstein. London: Routledge.

McKendry, S., and Boyd, V. 2012. Defining the "independent learner" in UK higher education: Staff and students' understanding of the concept. *International Journal of Teaching and Learning in Higher Education,* 24:209–220.

Orion, N., and Hofstein A. 1994. Factors that influence learning during a scientific field trip in a natural environment. *Journal of Research in Science Teaching,* 31(10):1097–1120.

Petcovic, H.L., Stokes, A., and Caulkins, J.L. 2014. Geoscientists' perceptions of the value of undergraduate field education. *GSA Today,* 24(7):4–13.

Ramsden, P. 1992. Learning to teach in higher education. London: Routledge.

Stokes, A., and Boyle, A.P. 2009. The undergraduate geoscience fieldwork experience: Influencing factors and implications for learning. *In* Whitmeyer, S.J., Mogk, D.W., and Pyle, E.J., eds., Field geology education: Historical perspectives and modern approaches. Boulder, CO: Geological Society of America, Special Paper 461, p. 291–311.

Vygotsky, L.S. 1980. Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Wenger, E. 1987. Artificial intelligence and tutoring systems. San Francisco, CA: Morgan Kaufman.

Wenger, E. 1998. Communities of practice: Learning, meaning, and identity. Cambridge, UK: Cambridge University Press.

Wenger, E., McDermott, R.A., and Snyder, W. 2002. Cultivating communities of practice: A guide to managing knowledge. Boston, MA: Harvard Business Press.

Zimmerman, B.J., Bandura, A., and Martinez-Pons, M. 1992. Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal* 29(3):663–676.

Zimmerman, B.J., and Cleary, T.J. 2006. Adolescents' development of personal agency: The role of self-efficacy beliefs and self-regulatory skill. *Self-Efficacy Beliefs of Adolescents,* 45–69.