FIELD NOTES

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The Earth never tires,
The Earth is rude, silent incomprehensible at first,
Nature is rude and incomprehensible at first,
Be not discourag'd, keep on, there are divine things well envelop'd,
I swear to you there are divine things more beautiful
than words can tell.

Walt Whitman
Song of the Open Road

Field trips are commonly the most memorable educational experiences for many students, and serve as excellent mechanisms in the recruitment and retention of students in geology programs (e.g. McKenzie et al., 1986; Karabinos et al., 1992). Field trips provide the opportunity for students to become motivated to learn, and participation on field trips results in measurable impacts on student values (sense of importance), interests , and attitudes (sense of enjoyment) about the subject matter (Kern and Carpenter, 1984). Field trips help us to experience the joy of working in a natural environment, the excitement of discovery, and the satisfaction engendered by mastery of content and increased appreciation for the methods of scientific investigation. At the same time, I'm sure we have all experienced field trips from hell on which students were ill-prepared to undertake the field trip activities, on which field trip "activities" degenerated into monologues by leaders that limited direct participation, on which litanies of names and places were presented out of context, on which activities were prescriptive and precluded exploration and discovery, on which participants were forced to endure death marches (or equivalent feats of physical heroism), or on which extreme personal discomfort was the result of lack of preparedness for the extant conditions or poor logistical planning. Due to the central role of field experiences in many geoscience curricula, it is fair to ask how we can ensure that field trips are optimal experiences for students--for learning and for personal development. Beyond the shared social experience and perhaps relief from routine coursework (there is some justification for fun, social outings), the question of overall effectiveness of field trips as educational activities must be addressed. Although there is not a large literature that speaks to this question (most of it derives from studies of K-12 field trips, not necessarily specific to geology), there are some clear indicators that have emerged about the characteristics of field experiences that are most effective for student learning.

The most important role of field trips in the learning process is in "direct experience with concrete phenomena and materials" (Orien, 1993). The very nature of field trip exercises requires students to be active learners, rather than merely covering material in a passive mode in a traditional classroom. Furthermore, experiential activities facilitate the transition from lower-order learning strategies (e.g. memorization of information) to the higher cognitive learning strategies required to master and retain abstract concepts (e.g. MacKenzie and White, 1982; Orien, 1993). Kern and Carpenter (1986) have shown that lower-order learning is virtually identical for all students whether or not they have participated in field experiences. However, they found that field experiences enhanced students' ability to understand, analyze, synthesize, and use acquired information and concepts. It is best to incorporate field trips in the early "concrete" part of a course, providing materials and contexts that can form the basis for future development of abstract concepts, and offering activities that cannot be used effectively in the classroom (Orien, 1993).

Perhaps the most important aspect of a successful field activity is a clear articulation of the activities, goals, and expected outcomes of the field trip. The instructional goals of a field trip may be: 1) to catalyze, enrich or culminate instructional units, 2) to introduce a new unit of instruction to create interest in the subject or topic, 3) to present a main body of an instructional unit as a tool to enhance and motivate learning, or 4) to illustrate and reinforce facts, skills, and concepts as a follow-up for class work(paraphrased from Rudman, 1994). Whatever the motivation, field experiences should be integral to the overall course of study, rather than merely used as an enrichment or add-on activity (Orien and Hofstein, 1994).

A solid body of evidence indicates that the educational effectiveness of a field experience is strongly predicated on pre-field trip preparation (Falk et al., 1978). Orien and Hofstein (1994) have reported that the educational effectiveness is controlled by two major factors: the field trip quality and the "Novelty space" (or Familiarity Index). The quality of the field trip "is determined by its structure, learning materials, teaching method, and the ability to direct learning to a concrete interaction with the environment" (ibid). Novelty space is defined in terms of three variables: cognitive, psychological, and geographic familiarity. Students' ability to conduct higher cognitive tasks (e.g. problem-solving) is largely dependent on their familiarity with the field trip setting. Cognitive preparation may include hands-on activities working with materials, concepts, or skills needed to perform the tasks expected on the field trip; simulations that explain processes and phenomena; and review of students' prior knowledge about basic concepts relevant to the field trip. Psychological preparation should include descriptions of the length of the trip, a detailed itinerary of what to expect (including food and bathroom stops), time constraints for the field activities, expected weather conditions, detailed lists of clothing and supplies that will be needed, and in general, any other information that addresses the students' health, safety and security. Often students will have had little or no prior experience in the field, and uncertainty about what to expect will affect their performance. Geographic preparation might include locating field trip stops on a map, review of geologic maps and preparation of cross sections, or perhaps showing videos or a slide show of the field trip location(s). Students placed in a new physical environment spend a significant amount of time becoming acquainted with the new location before they engage the tasks at hand.

Rudman (1994) makes the following suggestions, that prior to a field trip leaders should:

1. Create goals and objectives which justify the purpose of the field trip.
2. Implement an introduction or orientation before the field trip departure (e.g., slide show, speaker, discussion on what to expect and how to behave).
3. Reduce the environmental novelty for yourself and the students. Make a pre-trip inspection yourself and learn how to use the (available) resources. If time, travel or expenses do not allow for this, phone calls or letters can be just as helpful.
4. Select a field trip site that provides hands-on, materials to manipulate. Trip leaders should stimulate interest through questioning, problem solving, exploration and investigation.
5. Allow students time to experience the excitement of exploration and discovery. Certain behaviors should be expected, but the field trip does not have to be a regimental, single file line of silent students.
6. Administer post-field trip materials, projects, or activities to help students reinforce and transfer the learning experience beyond the field trip.

Orien (1993) presents a model for the development and implementation of effective field trips:

1. The main instructional strategy of the field trip should be hands-on experience, concentrating on those activities that cannot be conducted in the classroom or laboratory.

2. A process-oriented approach should be used to achieve the objective of hands-on experience. This approach involves assignments that direct the students towards activities such as: observing, touching, identifying, measuring, and comparing. Follow-up activities of interpretation and drawing conclusions should be based on these basic processes.
3. Students should be prepared for the field trip. The more familiar they are with their assignment (cognitive preparation), with the area of the field trip (geographical preparation), and the kind of event in which they will participate (psychological preparation), the more productive the field trip will be for them.
4. The field trip should be used as an integration with a particular unit because concrete activities in the field provide a basis for meaningful learning.

To assess the effectiveness of the field trip experience, Orien and Hofstein (1994) used the following evaluative mechanisms:

1. Pre-field trip questionnaires were administered on students' background, attitudes towards field trips, attitudes towards geology and a pre-field trip achievement test was given.
2. During the field trip, direct observations were made of student performance, students were interviewed, and students' attitudes towards the field trip were collected via a questionnaire.
3. Post-field trip surveys and interviews were conducted to determine students' attitudes towards field trips and geology, and an achievement test was given.

It is necessary to have a basic understanding of students' prior knowledge, interests, attitudes, and pre- or misconceptions to help formulate the field trip activities. During the field trip it is also important to monitor student performance (what they can do and what they know) as well as interest and attitudes to ensure that the field trip is a positive and meaningful experience. Post-field trip activities are also important to help reinforce the lessons learned on the field trip, and to help students reflect on the relevance of the field experience to the rest of their coursework, and to their personal lives.

So how do these general recommendations translate to effective field trips in mineralogy and geology? Given constraints of limited time, resources, and geographic setting, field trips are special experiences in most curricula so extra effort should be directed towards making these positive and meaningful learning experiences for students. The overall quality of the field trip will depend on the structure of the activities, learning materials, and teaching methods:

- Factors such as the selection of the field area (Falk and Balling, 1980), the geologic setting, potential for collecting quality specimens at a sampling locality are all primary considerations. Decisions must be made about the relative merits of conducting a regional overview with many stops, or doing a focused activity at one (or a few) locations. Locke (1989) notes that during long road trips the travel itself is disconnected to learning, even when traveling through geologically interesting terrane. The goals of either a regional trip or a site-specific activity should be clearly articulated with well-defined outcomes of the field trip (e.g. road logs, descriptions of field sites, collections of representative samples, etc.).
- Preparation of technical materials is essential. This includes compilation of geologic maps and road logs, and it is increasingly common for field trip leaders to provide supplemental information such as photomicrographs, chemical variation diagrams, etc. of work previously done that would not otherwise be available in the field. Any equipment to be used must be fully functional and safe to use.
- Make sure that arrangements have been made ahead of time to ask permission to access private lands, and to inquire of private landowners and government officials the best routes for access to a given property. We have had a number of our local field sites closed by private landowners

because "rogue" field camps have trespassed on private lands without permission. Field sites may simply not be accessible due to local conditions such as weather, floods, landslides, or construction, and contingency plans should be in place.

- Instructional methods will vary greatly, and are largely dependent on the learning needs of the students. The goals, nature of assignments, expected outcomes, and assessment mechanisms must be clearly articulated for the students. Whenever possible, discovery and inquiry should be at the heart of the field trip exercises. Srogi and Baloche (this volume) describe a number of interactive learning strategies that apply equally well in the field as in the lab (see also Munn et al., 1995). Assign students various tasks to perform in preparation of a field trip -- let them gain some ownership and a sense of responsibility by doing literature searches, planning logistics, contacting property owners, etc. At beginning levels, it is probably better to engage "directed-discovery" or "guided inquiry" so that students will have a place to start their investigations, and a context to gain understanding. At more advanced levels, "open-discovery" becomes possible as students become confident in their ability to ask appropriate questions, seek evidence, and formulate interpretations. Different working groups should be encouraged to discuss and compare results. At the end of each activity, it is important to achieve closure through reflection of the key relationships that have been observed. Keep a reasonable schedule, and plan activities that have a high potential for success. Make sure all students feel welcome, valued, and engaged; make an effort to interact with all students, and at areas with limited exposure, make sure that all students have access to your explanations.
- Field trip activities should be carefully integrated with other course materials, as well as across the curriculum. Samples collected on a field trip can be used for further analysis in the laboratory to simulate, replicate or contribute to research already done in an area.
- Preparation of the students is essential for effective learning, as described above. In a mineralogy course, this should include pre-field trip exposure to the scientific content, principles, and methods that will be used on the field trip. Background material should be presented to give students the geographic and geologic context of the field trip.
- Students should be psychologically prepared to take the field trip. The health and safety of the students is of paramount importance (see Cummins, 1992). Don't forget to bring hard hats and safety glasses! Prepare for bad weather, insects, and the possibility of first aid emergencies (bee sting, snake bite, lightning strike, rock-roll, abrasions, poison ivy, heat stroke, twisted ankles, . . ., and worse). Provide advice for appropriate clothing and footwear. Make sure personal needs are accommodated including reasonable breaks for food and bathrooms. Be sensitive to the special needs of handicapped students, single mothers who have to be back on time because of child care, or working students who have to be back in time for the night shift. You will be guests at many facilities, and field experiences may be new to many students, so they will need advice on how to act and what to do.

Most professors of geology have had the great good fortune to do field work as an integral part of our professional careers. Many of us started careers in geology because we were attracted to field work. No matter what the geologic setting of our present work environment there is the possibility of sharing our field experiences with students. Our enthusiasm for field work should be contagious. And field trips provide a natural opportunity to employ the best practices of discovery-based learning. However, to optimize the effectiveness of the learning experience, we need to do more than say, "Lets load up the vans and go" (although there does remain an allure for many of us to be explorers of the great unknown). I believe that we generally do a good job preparing the technical aspects of a field trip -- amassing geologic maps, sample locations, organizing equipment. We must acknowledge the significant contributions made by individuals and professional societies who have compiled geologic road logs for our communal use. We must also recognize our responsibility to adequately prepare our students--cognitively, in geologic space and time, and psychologically -- to optimize the learning opportunities afforded by field trips.

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