Using Experiential Learning Opportunities in the National Parks to Inform Science Classroom Practice

Michael P. Marlow, University of Colorado at Denver, P.O. Box 173364, Denver, CO 80217-3364; mike.marlow@cudenver.edu

Theoretical program bases

Experiential learning is a process through which a learner constructs knowledge, skill, and value directly from an experience within the environment. Learning occurs when carefully chosen experiences are supported by reflection, critical analysis, and synthesis. Experiences are structured to require the learner to take initiative, make decisions, and be accountable for the results. The results of the learning are personal and self constructed, preparing for and leading to future experiences and learning. Relationships within the experience are developed and nurtured. Lave and Wenger (1991) suggest that individuals learn as they participate by interacting with a community, its history, assumptions and cultural values, rules, and patterns of relationship; the tools at hand, including objects, technology, language and images; the moment's activity, its purposes, norms, and the practical challenges. Shared knowledge emerges from the interaction of these elements. The interactions and shared experiences result in what Davis and Sumara (1997) refer to as a "commingling of consciousness." As each participates, the relational space among them all changes. This is "mutual specification" (Varela et al. 1991), the fundamental dynamic of systems engaging in mutual action and interaction. Activities that involve professionals in open and dynamic discussion, mutual problem solving and/or collaborative learning, draw the participants into a community of learners or professional cohort and contribute to a deeper shared understanding of an experience.

The use of a field site such as a national park considers this theoretical base in planning meaningful activities. The field experience is designed to meet all of following program objectives.

- Increased knowledge of science content.
- Holistic understandings of the connections and relationships within the selected environment.
- Skill development in doing science inquiry utilizing the field site resources.
- Support for implementation of critical thinking and problem solving skills.

For maximum impact, the learner must be actively engaged in the experience and the experience must be structured to require the learner to take action, draw conclusions and support their understandings. Another important component of the experience is the nature of interactions among participants. The more positive the interaction, the more likely the experience will be viewed favorably. In any group experience, when relationships are developed and nurtured, the group has the potential to evolve into a community or cohort. The key to group learning is not so much the destination, but rather the chance to participate in a true learning experience within the context of a cohort in a rich environment.

What does an inquiry-based national park visit look like?

In designing an inquiry-based approach for the participants, the experience is something that they do, not something that is done to them. As a result they must actively construct knowledge by making connections with and building on prior knowledge, and working with and using science ideas and concepts. As such, scientific ways of communicating, thinking, evaluating evidence, constructing arguments, and problem solving become central aspects of the experience. The visit must be well planned, the participants well prepared for the content to be explored and there needs to be an over arching theme to the investigation.

General planning approach: Developing an overarching theme

The first step in any field experience is to identify the connecting theme for all the activities. Visiting a site or series of sites without a connecting theme results in unpredictable learning. Unifying the activities through such a theme allows the content to transfer from a base knowledge of definition and description to complex understanding of interactions and relationships.

Hawaii Volcanoes National Park example. The theme used for Hawaii Volcanoes is change from newest lava on the Big Island to oldest on Kauai. This theme looks at the rock chemistry, plant adaptation, surface features, and human interaction. The flow of activities reinvestigates these four components at each new site. Observing new land formed through eruption and later the chemical breakdown of these lavas into clay and sand becomes the conceptual base for the activities. While at Hawaii Volcanoes, participants visit numerous locations at the summit caldera; hike out to PuuOo (the present eruption site) and later down to the ocean to view lava entering into the ocean (newest land). While on Kauai, the group visits Waimea Canyon and the Na Pali Coast for chemical breakdown and soil studies.

Grand Canyon National Park example. The theme in this study is identifying ancient environments through rock characteristics utilizing national park and other sites, from Capitol Reef National Park, down the Grand Staircase, through Escalante, Bryce Canyon, Zion, Marble Canyon, and finally rafting through the Grand Canyon. Initial sites of sedimentary rocks are used as lecture points to review and observe environmental characteristics. Then sites in the Grand Canyon are used by the students utilizing the knowledge learned earlier to interpret the environments for the instructor. This transfer of responsibility moves the knowledge to understanding for the students through application.

Identifying appropriate site resources

Planning field experiences. Park information and other resources are extensive and available for most sites. Park websites provide a great deal of this information. However, the understanding of this content by the instructor/planner is obtained during a site visit prior to the group field study. Utilizing trail guides and maps, study sites are identified based on the study objectives, Rangers provide specific information through guided hikes and visitor center talks, and at the information desk. Geographic information systems (GIS) and contour maps are identified for the field site. Without the on-site planning the educational objectives will be difficult to address.

A content-analysis procedure is used to evaluate NPS on-line and written content selected for the field study. The procedure is based on the learning objectives determined for the field study. The steps are given in Table 1.

Hawaii Volcanoes example. A detailed field guide is developed to provide specific content information, field study directions, and activities. The guide uses a day-by-day timeline. Content information was derived from published sources produced at the Hawaii Volcano Observatory, the Hawaii Volcanoes website, and the U.S. Geological Survey (USGS) and National Park Service (NPS). Trail guides and volcano safety information from the park are used.

Table 1. Steps in the content-analysis procedure.

• Make a preliminary review of the materials to determine if they address the targeted learning objectives. • Analyze the materials for the alignment between content and the theme of the field study. Important criteria considered in this step of the analysis include the following:
1. Materials support the field study theme.
1.1. Can the materials be used to support an overall sense of purpose and direction that is understandable and motivating to students?
1.2. Can the material be used to support the purpose of each activity and its relationship to others?
1.3. Can the materials be used to involve students in a logical or strategic sequence of activities (versus a collection of activities) that build toward understanding of a concept(s)?
2. Materials support the student's prior knowledge.
2.1. Can the material be used to support specific prerequisite knowledge/skills that are necessary to the learning of the content?
2.2. Can the materials be used to explicitly address commonly held ideas the teachers may bring into the experience?
3. Materials engage the students with phenomena.
3.1. Do the material provide multiple and varied science phenomena to support the field study theme?
3.2. Do the materials support activities that promote first-hand experiences?
4. Materials develop and use scientific ideas.
4.1. Can the materials be used to develop an evidence-based argument in support of the field study theme?
4.2. Can the materials be used to introduce technical content knowledge in conjunction with experience that facilitates thinking and promote effective communication?
4.3. Do the materials include accurate and comprehensible representations of scientific ideas?
4.4. Do the materials explicitly draw attention to conceptual connections?
4.5. Can the material be used to provide tasks/questions for students to practice skills or use of knowledge in a variety of situations?
5. Materials promote student reflection.
5.1. Can the material be used to develop tasks and question sequences to guide student interpretation and reasoning about the experiences?
6. Materials enhance the learning process.
6.1. Can the materials be used to explicitly draw attention to appropriate connections to other content?

Grand Canyon example. The Grand Canyon field guide is divided into a number of sites located in various national parks. Information for each site is obtained from park websites and USGS resources. Colorado River guidebooks are used on the raft.

Establishing content base and then transferring to understanding through problem-solving

Field guide development. Content base development is the traditional purpose of field experiences. An instructor leads the learners through guide walk, roadside stops, and field lectures. Learners dutifully take notes, draw pictures and record observations. Activities such as this may develop some understanding on the part of the student and perhaps support later classroom discussions. To increase the value of the field experience the newly learned or observed content needs to be applied through a series of problem solving, critical thinking activities. These activities need to become more complex as the field experience progresses.

Hawaii Volcano example. The approach to this field experience first requires the development of knowledge about lava chemistry, volcanic formations and features in order to establish a content base for the following field problems. Prior to the trip, I provide each student with readings, a field guide ,and specific information on each site. These materials are enhanced by a range of USGS/NPS on-line documents and trail guides. Once at the park the first priority is to build on the content knowledge. For example the first morning at Hawaii Volcanoes utilizes a series of sites and trails beginning with a hike down the Halemaumau Trail. Along the trail and onto the caldera floor, the students are introduced to lavas and features: fault blocks, fissures, tumulus structures, pahoehoe and aa, lavas, lava chemistry and breakdown. Later that morning: lava tubes, volcanic ash, cinder, ejecta, and rift zone features. In the afternoon the activity changes to student interpretation. The Kilauea Iki crater floor is used as the site for the first student application. They develop an interpretation of what happened during the Kilauea Iki eruption, applying the content learned in the morning. This approach is utilized throughout the rest of the field study, alternating content learning through instructor lecture and group discussion at one site, and individual learner application of the new content at a new site.

Grand Canyon example. This field study utilizes a different approach. Content is developed through a series of stops on the way to the canyon. Sedimentary rocks in the various parks are investigated as to composition, structural features, and sediment sorting. Methods of identification are modeled such as sedimentary signatures. The students keep field notes and iPod audio records of the various environments and identification features. In the second stage of the field course while rafting through the canyon, the students do the interpretation and explain their conclusions.

Reporting understanding

Post-trip report development. It is extremely important in the establishment of true understanding that the learner design and implement a means of explaining their understandings. The process of doing so forces clarification and deepens understanding. During the actual field experience this reporting is done verbally. Following the field experience the reporting is presented in a more formal way utilizing such technologies as power point or digital stories. These presentations utilize GIS/global positioning system (GPS), digital photography, and iPod recordings.

Technology

On our field studies, students use an iPod with a voice recorder to take notes and a digital camera to take photos. They then create a digital movie in iMovie.

iPod. We use Apple iPods (30 GB 7500) with a Micromemo microphone allowing us to easily record in the field. The microphone is attached to the iPod through the remote/ headphone connector, basically sitting on the side of the iPod. It is omni-directional. No special software is required beyond the iPod software. The iPods are easily connected to Macs via iTunes and also work with Windows XP or 2000 on PCs. With either attachment the iPod can record interviews to hard disk. The iPod has mono, low-resolution sound recording capabilities. Sound quality is outstanding, battery life excellent, and recording capacity amazing (hours and hours). With a hard disk, there is no media to purchase, lose, or have jam up. The unit is very small. Transfer to computer is via a USB cable, usually included.

Digital photography. We use both digital stills and video for our inquiries. Images are stored on a computer in files identified by content titles. All participants contribute to these files that are later made available to all for the digital story development.

GIS/GPS. GIS is a computer program for storing, retrieving, analyzing, and displaying data. It combines two kinds of information or databases. One is geographically referenced information: latitude and longitude coordinates, and spatial or location information. The second is attribute or descriptive information: characteristics or qualities of a particular place. Attribute data could be natural resources (e.g., trees, soil types), infrastructure (e.g., trails) or events (e.g., eruptions, earthquakes). We use GIS/GPS technologies to enrich understanding, locate sites on maps, and provide context for the data collected.

Digital stories. Education student field reports have traditionally been written narratives or PowerPoint presentations that asked students to describe the experience, perhaps answering some questions and reflecting on impacts in order to demonstrate active participation. This approach limits student products—both text and electronic—to being mostly summary reports: a slide show on geological terminology, or a PowerPoint product showing the site features. However, a true knowledge-building environment facilitates inquiry research to support producers of information. We use digital story technology for this purpose. This enables learning to be centered around critical questions, deeper levels of understanding, and expecting original thinking that goes beyond existing information rather than patching together known facts. Digital stories allow the use of digital stills and movie clips, iPod recordings, and GIS maps to develop a report of findings, observations and impacts of the experience.

We use video editing tools that are low-cost or free: Apple's iMovie on the Macintosh platform, Microsoft's MovieMaker2 and Pinnacle Studio on the Windows XP platform. Microsoft has also created PhotoStory, an inexpensive program that is part of Windows XP Plus Digital Media Edition to create digital videos from still images, and Apple's iPhoto for Macintosh OSX is used to create digital videos from still images.

Recommendations

The national parks provide great locations for field studies. Websites for these parks contain a great deal of valuable information. What is not easily available is GIS information on many of the parks. GIS maps and site-specific data would allow research activities related to the park. Virtual trail guides would provide an invaluable resource for trip preparation.

References

Davis, B., and D. Sumara. 1997. Cognition, complexity, and teacher education. *Harvard Educational Review*, 67:1,105–125.

Lave, J., and E. Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation.* Cambridge, Mass.: Cambridge University Press.

Varela, F.J., E. Thompson, and E. Rosch. 1991. *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, Mass.: MIT Press.