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ABSTRACT

Visual learning has long been recognized as an integral process in educating biology undergraduates, who must develop specific visual skills and knowledge in order to communicate and work in the extensive visual culture shared by practicing biologists. Student experiences with field observations and the development and application of verbal/visual language in the field setting are often problematic, however. One way of improving the design of field experiences in biology is to consider the kinds of visual tasks that are required for learning. For example, organism identification deals with individual variation among living specimens, which often requires active assessment of visually complicated information; experienced biologists use some subset of this information to shorten the identification process. When students depend on a single image or on a photograph or drawing or a "typical" example to identify a specimen, they may be unable to deal with the diversity within a population of similar specimens. Other complications for beginners are limited observation time in the field and the image familiarity demanded by the field manual and dichotomous key. The ability to identify an object requires more than general familiarity of forms, but also judgments based on re-examination of the nature of that familiarity. Field studies that incorporate collaborative investigations may provide this kind of practice. (Contains 12 references.) (AEF)

Visual Learning in Field Biology

by Ethel D. Stanley

Abstract

As in other disciplines, the study of biology presents an evolving set of visual learning, visual thinking, and visual communication requirements. Visual learning has long been recognized as an integral process in educating biology undergraduates who must develop specific visual skills and knowledge in order to communicate and work with the extensive visual culture shared by practicing biologists. In this paper, a number of visual tasks necessary to field study within the biological sciences are identified and the proactive design of visual learning experiences is urged.

Individuals, no matter their age, view the world through experienced eyes. However, anyone who has been on a field trip designed to give you the opportunity to see things you've never seen before, can relate how variability in individual knowledge and visual practice makes "looking" considerably more complicated than just "opening your eyes."

Consider the following activities of practicing field biologists:

1) A paleobotanist systematically examines a fossil and suggests that it is a stem from a cycad that might have been found in the area nearly 200 million years ago.

2) A field evaluator makes notes on the extent of aphid damage to beans after inspecting only one or two plants and quickly scanning the color of the field.

3) As a result of studying a water sample under a microscope, a forensic phycologist states that a diatom bloom is responsible for the odd color and odor observed in the company's hot water ditch.

In each of these scenarios, a biologist is shown using specific visual literacy skills and knowledge. Each had to become proficient with a visual language that enabled them to store and retrieve specific images as well as communicate about them. Did they accomplish this learning as a result of performing specific visual tasks? Are there learning conditions necessary to develop this "coming to know?" Is there a current concept of visual learning within the biological sciences that helps define these conditions?

Although observation is considered essential to all biological investigations, visual learning itself is somewhat unevenly addressed and the concept of what it means to be visually literate in biology is largely ignored. Nonetheless, students majoring in the biological sciences not only must develop specific visual skills such as microscopic examination of tissues or field identification of organisms, but also utilize their knowledge of images for thinking and communicating. They continue to build and rely on this visual literacy throughout their educational and professional lives.

Educators in the biological sciences have long recognized the value of observation. Cooper (1917, p.12) presents this student view of learning under the supervision of the well known naturalist, Louis Agassiz, in his Harvard lab during the 1860's :

"Observation and comparison being in his opinion the intellectual tools most indispensable to the naturalist, his first lesson was one in looking. He gave no assistance; he simply left his student with the specimen, telling him to use his eyes diligently, and report upon what he saw. "

Observing and illustrating specimens remained a dominant form of learning at least through the first half of this century. It is hardly surprising to learn that "the making of 'carefully prepared detailed drawings' is a commonly required college laboratory activity in the biological sciences" (Johnson 1940, p.70). At the same time, visual components were introduced and increased in number and type in both texts and laboratory manuals. For example, eighty-five separate illustrations appeared in the first hundred pages of a commonly used undergraduate text, Introduction to Botany, written by Bergen & Caldwell (1939). This trend continues today. Blystone & Barnard (1988) compared college biology major textbooks in the 1950's with those of the 1980's. Use of photographs increased nearly threefold. Learners process more visual messages than ever before in the present day biology classroom:

"Illustrations have become an essential part of the biology learning experience, encompassing graphs, charts, flowcharts, diagrams, line drawings, photographs,and symbols, illustrations are found in textbooks, computer programs, instructional audiovisual media, and even classroom wall coverings" (Blystone 1989, p. 155).

Images are also generated by biology students. Knorr-Cetina & Amann (1990, p. 259) report "the focus of many laboratory activities is not texts, but images and displays." These are not passive media, but "objects on which work is performed in the laboratory; like other materials handled in the stream of laboratory activities, they are processed" (Knorr-Cetina & Amann 1990, p. 262).

Visual learning involves the synthesis of images as well. White (1988, p.152) writes:

"Science learning involves much processing of images. As well as learning many propositions and intellectual skills, we build up representations of unobservables such as electrons and magnetic fields, processes such as dissolving and burning,and generalizations such as sedimentary rock and plant cells."

With the proliferation of images encountered in biological education and the growing need to deal with them on an individual and professional basis, conceptual frameworks such as "visual learning" and "visual literacy" are increasingly relevant and should be considered actively within the educational setting. Visual learning can be defined as "the acquisition and construction of knowledge as a result of interaction with visual phenonema." (Seels 1994, p. 107). It is an important component of visual literacy, "the ability to understand and use images, including the ability to think, learn, and express oneself in terms of images" (Braden & Hortin 1982, p. 41).

Biology in the Field

Student experiences with field observations and the development and application of verbal/visual language in the field setting are often problematic. One way of improving the design of field experiences in biology is to consider the kinds of visual tasks that are required for learning. Activities that experienced and inexperienced field biologists must engage in should be examined. Students may be unaware of specific visual strategies that could enhance their field experiences. Examples of expected performance as well as opportunities to practice in order to develop visual expertise are needed.

Field biologists often begin by isolating an organism in the field using characteristics such as relative size, placement in a general community, association with other organisms including those like itself, critical behaviors, and key physical features. For example, in order to locate Prairie Dock in central Illinois during July, a botanist might look for this 4-8 foot flowering plant in remnant prairie areas found along railroad tracks. Other plants found with Prairie Dock include Compass Plant, Big Bluestem, and Blazing Star. Bright yellow flower heads towering over very large elephant ear-like leaves clustered at ground level and half hidden by grasses are key physical features.

Experienced observers frequently create search images which are practiced and revised as they encounter the organism under a variety of conditions. Identification deals with individual variation among living specimens. This often requires active assessment of visually complicated information. Experienced biologists use some subset of this information to shorten the identification process. For example, a search image for Rosinweed, a member of the Silphium genus like Prairie Dock and Compass Plant, might be simply the right angle formed where the stiff horizontal leaves meet the stem.

Beginning observers also try to shortcut the process. They often rely on drawings made by professionals that represent the typical specimen most likely to be encountered. Representation of a species in a single black and white diagram may function well for an expert, but may fail by not conveying detailed constructs to novice learners. Grinnell (1987) points out that "an observer's ability to recognize 'one of these' depends on being able to recognize the form of the object." These objects "have gestalt" in which "arrangement of component features provides information not apparent in the features alone."

When students depend on a single image to identify a specimen, they may be unable to deal with the diversity within a population of similar specimens. This concern is not limited to recent educators. Curtis(1897, p. viii) emphasized in his textbook of botany:

"...a variety of species have been used rather than a few types, since...this, above all, preimvents those false generalizations and conceptions that must follow a narrow study of forms."

Also, most biology students are unaware of the role of the scientific illustrator in creating these images. A sketch of a plant could reflect that the illustrator "knows what the plant is like in other views, and organizes an image with a greater richness of content" (Arber 1950, p. 210). Often the organism is enhanced to "show off" the distinctive features as field marks.

Another complication for beginners is the limited observation time in the field. Learners may be required to discriminate between distinctive features of a flying insect at a glance. Did that insect have long antennae or long cerci? Were the mouthparts for chewing? Perhaps the specimen can only be encountered in the field under special conditions. Identification of stunned fish following electroshocking may be limited to 90 seconds depending on the size of the fish.

The most common tools for field identification are the field manual and dichotomous key. Both require surprising familiarity with terms and images. Although field manuals contain sections that provide defintions of terms, illustrations of several types, and tutorial information, the learner may find this description information inadequate until several specimens can be examined. These manuals are awkward to access when they are needed most, ie. upon encountering specimens that the learner is unfamiliar with. These texts often require the learner to refer to two or more pages repeatedly in order to eliminate the confusion between similar specimens. The dichotomous key requires students to work linearly towards an identification. Misidentifying a grass because you missed an ambiguous, but critical glume character in an early step is especially frustrating!

Finally, the expectation of the learner is an essential component of the visual experience. Beveridge (1957) warned, "We are prone to see what lies behind our eyes, not in front of them." Searfoss (1995) advises novice observers to "beware of your preconceptions." The ability to identify an object requires more than general familiarity of forms, but also judgments made based on re-examination of the nature of that familiarity. Field studies that incorporate collaborative investigations in which an observer must communicate with others about what is being observed may provide this kind of practice.

Visual tasks associated with field biology that have been discussed here include the identification and assessment of critical features and contextual characteristics, development of short-cut discriminatory practices, the use of illustrative images, the use of dichotomous keys and field manuals with precise verbal-visual languages, and the need to recognize the power of expectation. Some of the difficulties that students encounter when carrying out these tasks are also described. Both visual tasks and the nature of the problems learners face should be considered in designing meaningful visual learning experiences in field biology.

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