

# On-line Laboratories for Introductory Biology to Enhance Web-based Learning

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The co-authors have developed on-line laboratory exercises for introductory biology that can be used as extensions of wet labs, as lecture-associated homework, or in distance education. Although it is not possible to recreate an entire “wet lab” experience, we have developed a combination of video, simulations, virtual microscopy, and game-like exercises that stress concepts and place students in the role of a working biologist. This presentation illustrates two interactive exercises: one that simulates a field trip to a forest ecosystem, and one that uses the experimental approach to solve a problem in evolutionary ecology. The virtual field trip utilizes an interactive panorama of a forest in the Raleigh area. Students locate habitats within the forest and view linked videos of different plants and animals. To illustrate ecological concepts, students are required to construct a productivity pyramid that places the organisms at the appropriate trophic level. The second exercise uses the application Quandary (Half Baked Software) to provide an interactive “case-study” of natural selection. Students play the role of a biologist in Trinidad and use the scientific method to determine why guppies found in two pools differ in coloration. As the study progresses, students collect data on the guppies and interpret experiments performed both in a laboratory and in the field. They answer questions as the study proceeds to verify their understanding of the material. These exercises may be viewed on our website and are freely available to educators.

**Keywords:** on-line laboratory, virtual field trip, case study, scientific method, ecology, evolution

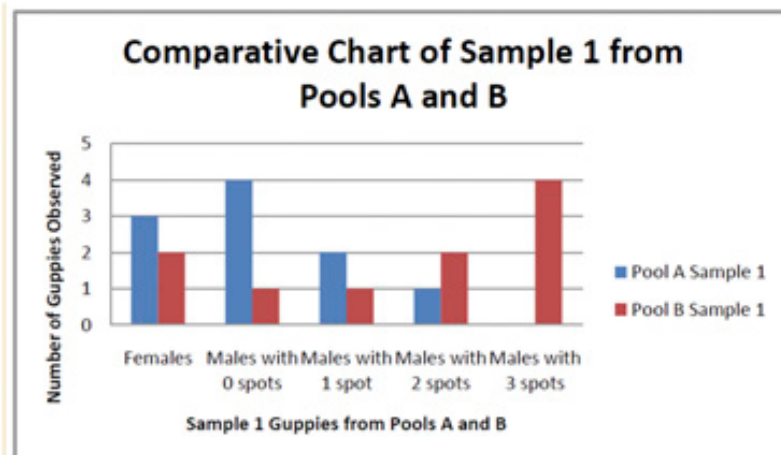
**Link to Original Poster:** <http://www.ableweb.org/volumes/vol-33/poster?art=41>

## Introduction

In fall 2008, we began development of on-line laboratory components so that students could earn full credit for the BIO 181: Introductory Biology without attending campus laboratory sessions. The major disadvantage of an on-line laboratory is the lack of hands-on experience with the techniques and instrumentation commonly encountered in an introductory biology laboratory. Although it is not possible to recreate an entire “wet lab” experience, we have developed a combination of video, simulations, virtual microscopy, and game-like exercises that stress concepts and place students in the role of a working biologist. An advantage of the online laboratory approach is the ability to conduct experiments and take “field trips” that are not feasible in classroom sections due to financial and time constraints. We utilize weekly, graded assignments to assure that students spend time synthesizing information and solving problems based on the laboratory material. All homework assignments utilize WebAssign at <http://www.webassign.net/>. This Internet site provides a wide assortment of question types, including “file upload” which allows students to send files to WebAssign for grading.

### Case Study Using the Scientific Method

This exercise utilizes the application Quandary (Half Baked Software) to provide an interactive experience in evolutionary ecology. Students play the role of a biologist in Trinidad using observation and experimentation to determine why guppies found in two pools differ in coloration. As the study progresses, students collect and analyze data on the guppies (Fig. 1). They read a scientific article to gather more information, and then interpret experiments performed both in a laboratory and in the field. Students must answer questions as the study proceeds to verify their understanding of the concepts.



**Figure 1.** Picture of a pool and graphs of data that the student-researchers collect as they move through the guppy case study. At each step, there are several choices, but eventually the student will obtain data from 6 different experiments.

## Virtual Field Trip

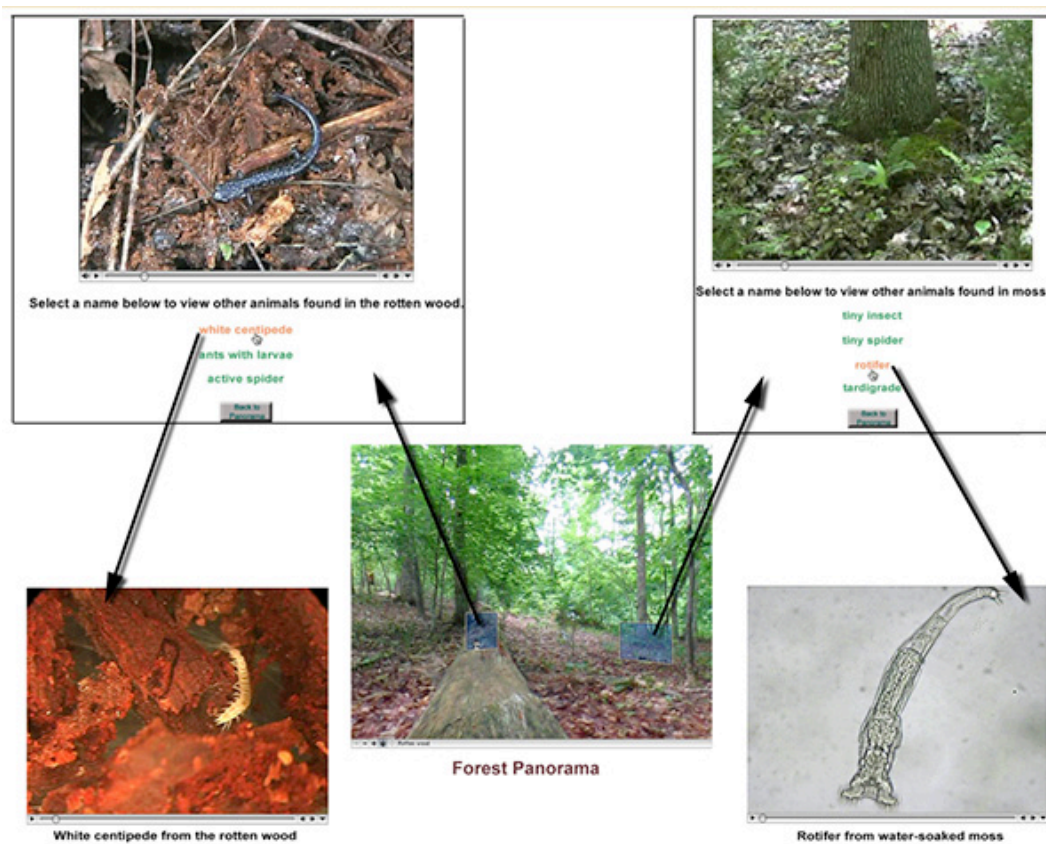
We are using panoramas with linked hot spots to simulate field trips to locations of ecological interest. The following exercise utilizes an interactive panorama of Schenck forest (Raleigh area) with video clips of plants and animals found there, including microscopic forms. Students open the panorama and locate habitats within the forest as indicated by hot spots (Fig. 2). As they turn 360° within the panorama, more hot spots are found. They list the plants and animals that they find and place them in a table that indicates the forest strata or microhabitat in which each was found. To illustrate ecological concepts, students are required to construct a productivity pyramid that places each organism in their list at the appropriate trophic level. The completed table and pyramid are submitted to WebAssign for grading. This exercise is part of our online Ecosystems laboratory and can be viewed at <http://www.ncsu.edu/project/bio181de/Lab/ecosystems/ecosystems1.html>.

### Student Response

Students submitted an optional poll at the end of the course to express their opinions of the on-line labs. Comments on both exercises were positive. When asked to choose their favorite online lab from the 12 in the course, 12% of students picked the case study and 34% picked the ecosystems lab (consisting of the forest panorama plus the game “Extinction.”) Examples of comments were:

“Scientific Method was my favorite because I feel like it was a “real world” experiment. I enjoyed trying to solve and understand the problem.”

“I liked the forest panorama lab the best because I felt like I was actually in the field looking for plants and animals.”



**Figure 2.** One view within the forest panorama with two hot spots indicated. When a hot spot is clicked, a page opens containing a narrated video that shows one or more organisms within the area. Clicking on the names beneath the video brings up additional video clips of animals too small to be easily seen. These were videographed in our laboratory in samples taken from the forest.

“My favorite was the ecosystems lab, where the game and forest panorama was utilized. It was nice to do something interactive rather than just read and answer questions.”

Students were also asked to select which (if any) concepts that they understood better after performing the Scientific

Method and Ecosystems laboratories. A majority of students indicated that they had a better understanding of designing laboratory experiments and applying scientific literature to a project after completing the guppy case study (Table 1). Relative to the forest panorama, a majority felt that they better understood forest stratification and microhabitats after finishing the exercise (Table 2).

**Table 1.** Student response to the case study exercise.

Concepts (Select all that apply)	% of Students Selecting Each Concept*
Natural selection	44
The scientific method	41
Designing laboratory experiments	60
Designing field experiments	24
Applying scientific literature to a research problem	54
Data analysis	35
None of these	6

\*Percent of the 111 responding students that selected each concept

**Table 2.** Student response to the forest panorama exercise.

Concepts (Select all that apply)	% of Students Selecting Each Concept*
Stratification of the forest	59
Trophic levels	31
Energy flow through an ecosystem	47
Microhabitats	61
Types of plants and animals found in a forest	23
None of these	4

\*Percent of the 111 responding students that selected each concept

### Use of the Web-Based Exercises

These exercises are copyrighted to NCSU and are available to educators free of charge. They may be downloaded, modified, and used for any educational purpose. The case study on guppy coloration and the forest panorama can be viewed and downloaded from <http://explorethelior.org>. Login as a guest and use the search term “biomovies” which brings up all items provided by Black and Niedzlek-Feaver. Then, to

narrow down the list, use the key words “guppy” or “panorama”. The above exercises can be viewed from the website or downloaded as ZIP folders. All files must remain in the folder for the exercises to work properly.

For questions about the exercises or assistance in downloading, contact Betty Black.

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### Mission, Review Process & Disclaimer

The Association for Biology Laboratory Education (ABLE) was founded in 1979 to promote information exchange among university and college educators actively concerned with biology learning and teaching in a laboratory setting. The focus of ABLE is to improve the undergraduate biology laboratory experience by promoting the development and dissemination of interesting, innovative, and reliable laboratory exercises. For more information about ABLE, please visit <http://www.ableweb.org/>

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