Using Technology to Blend Teaching & Basic Research

A set of online modules puts current research data into students' hands

Jacqueline McLaughlin

Research-oriented instruction emphasizes the central purpose of science—inquiry. Teachers who understand the research that fuels science—and not just the core concepts in textbooks—can help students become perceptive, informed citizens. These teachers will feel more confident about science content and teach it with a higher degree of skill—building both student knowledge and analytic ability.

CHANCE Participants and Module Creation

CHANCE works closely with conservation sites and established researchers, organizations, and academic institutions in Costa Rica, Pennsylvania, and around the world. CHANCE participants are inservice and preservice teachers who travel to Costa Rica to work in the field for three weeks alongside field researchers at selected conservation sites as part of their scientist training. During the trip, the teachers perform daily research-based field work, ecosystem exploration, peer and professional presentations, and discussions. To maximize their field experience, they maintain a daily journal, attend lab meetings, and record and report all data gathered from daily research activities.

Following their return to the United States, teachers attend an all-day workshop where they are trained to use and develop web-based "research modules." After independently working through several completed modules, teachers outline a mock research module "storyboard" (a written description of a module's page-by-page content, including text and intricate details of all animations and activities)—the key element of module development. Module topics are based on environmental and conservation issues current in Pennsylvania, the nation, or the world and cover the Pennsylvania State Standards in Environment and Ecology (grades 10 and 12). Teachers who are selected to author a module are paired with research scientists and/or specialists in the selected field of study ("CHANCE mentors") to acquire current and relevant data, expert advice, and guidance regarding their module's topic.

The goals of the CHANCE (Connecting Humans and Nature in the Costa Rican Environment) program are based on "scientific teaching" and are explicit: Train high school teachers to be more like scientists and then develop a unique, pedagogical tool for their classrooms that puts current research data into the hands of students. The underlying objective is for teachers and students to learn the real science behind biological concepts and mandated standards. The CHANCE program is a coordinated effort between The Pennsylvania State University (PSU) and the Pennsylvania Department of Education (PDE) that trains 9th- through 12th-grade teachers in environmental science and ecology. The program provides teaching strategies that will develop students' knowledge of and concern for the environment and its biodiversity (McLaughlin 2006).

The PDE now recommends the use of CHANCE research modules as a way of helping high school students meet the nine state standards in environmental science and ecology. Because most states must meet similar standards, the CHANCE program provides a viable framework for renewing high school biology education nationwide. (For more details of the teacher training see CHANCE Participants and Module Creation.)

The CHANCE Module

Today's youth spend an average of six and a half hours a week using various forms of media. And time spent on computers more than doubled over the last five years (Kaiser Family Foundation, *www.kff.org/entmedia/entmedia030905pkg.cfm*). Using digital technology is second nature to students born between 1980 and 1994 who prefer video, audio, and interactive media, and learn by doing (Carlson 2005). The CHANCE research modules take advantage of students' digital propensity and promote inquiry-based learning by putting virtual, real research data from

FIGURE 1

In the module "The Biology and Plight of the Leatherback," students examine the life cycle, range, and nesting habits of Leatherback sea turtles. This module was authored by PSU preservice high school teachers Sarah Kepner, Jennifer Polignone, Krista Pummer, and Pamela Yerkes. The teachers worked with Joana Hancock who is the Project Coordinator for the conservation group Asociación ANAI in Costa Rica and an expert on Leatherback sea turtle biology and conservation. Serving as mentor was Scott Eckert, director of Widecast and a professor at Duke University. [This and all other CHANCE modules are freely available at *https://royercenter.cwc.psu.edu/CHANCE.*]

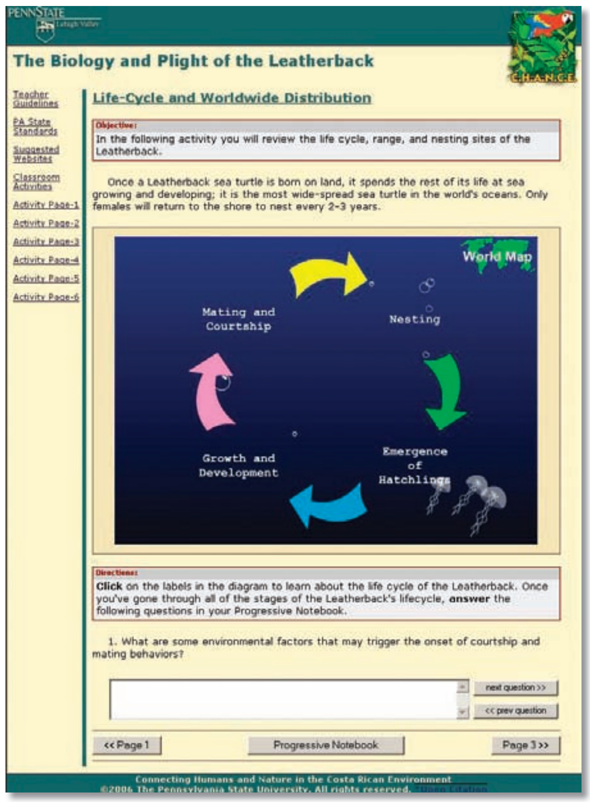


FIGURE 2

Later in the module, students collect, record, and analyze real data—simulated here to help them research the abiotic environmental beach factors that determine nest incubation temperature. They use the data collected to predict the gender of the hatchlings in selected nests.

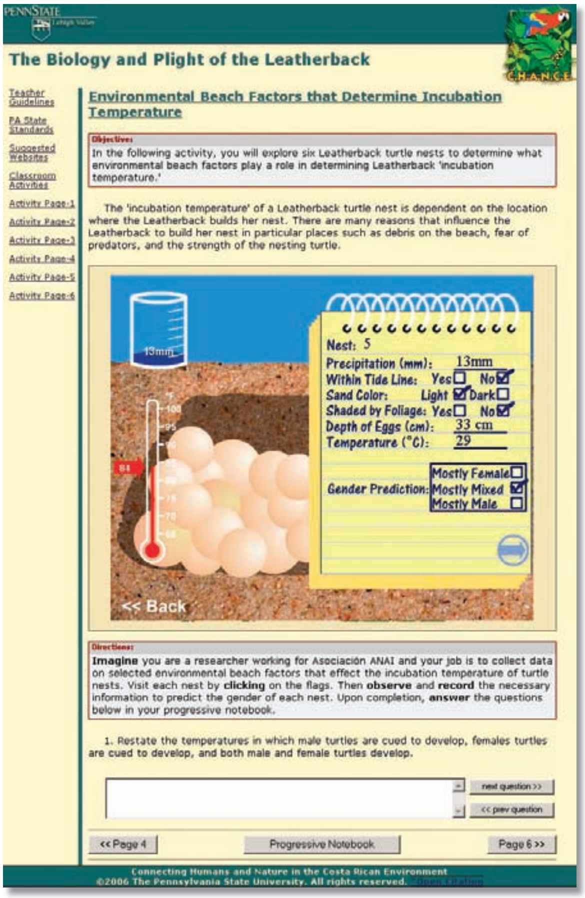
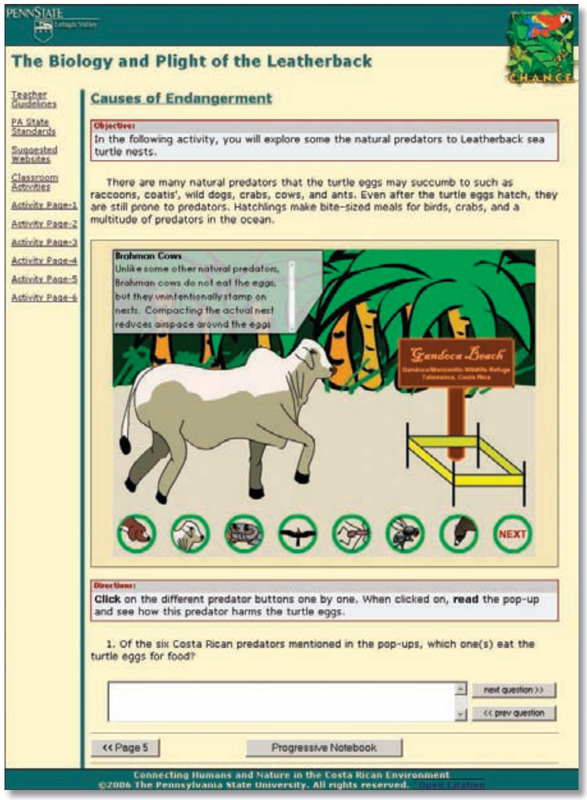


FIGURE 3

In the last portion of the module, students examine conservation issues, either natural or man-made, that can negatively affect egg survival.



leading scientists into the hands of high school students. Best of all, CHANCE modules promote active learning by providing opportunities for students to participate as individuals directing their own learning process.

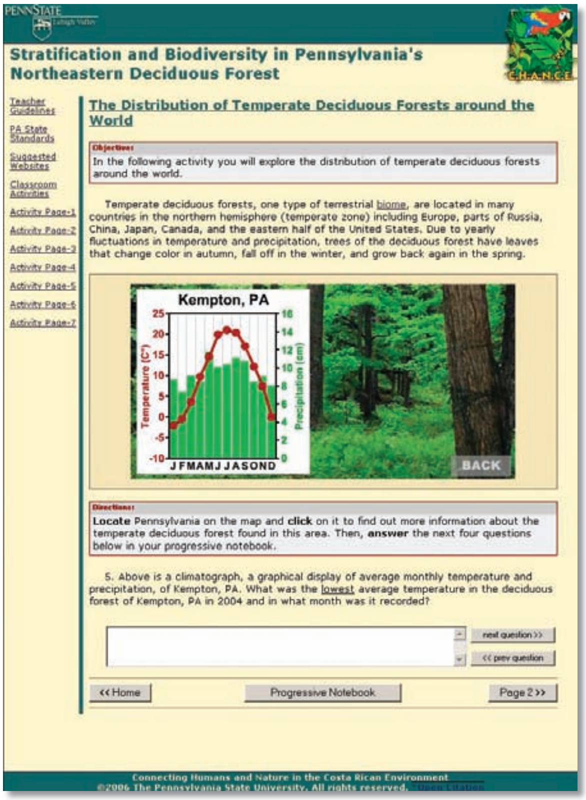
Each module maximizes classroom or laboratory functionality. In addition to an animated research scenario, the modules' template includes links to teacher guidelines; state standards; suggested websites; and creative, active, collaborative, and experiential classroom activities. Unique to these interactive modules is CHANCE's "progressive notebook," which allows students to continually record their experimental research findings as they progress through the module—observing and carrying out a virtual experiment—in the manner of a "real-life" researcher collecting data.

Once a module is completed, the progressive notebook component can then be printed for teacher review. While answer keys are available for each module (teachers can e-mail the appropriate author or me), a teacher using a module should first complete it in its entirety to become familiar with the content and the scientific methodology employed, then set up a rubric to grade students' answers. Also, teachers who have their students complete the suggested additional "Classroom Activities" that are provided for each module on a side link, may choose to grade these as well.

CHANCE modules are meant to be authentic learning tools for both teacher and student; they are not meant to be "online" textbooks or test banks. They should be considered just one pedagogical tool in a teacher's repertoire and never meant to replace an entire curriculum. To cover all of the academic standards for environment and ecology and to cater learning to meet all types of learning modalities, the modules can and should be used in conjunction with textbooks, classroom discussions, laboratories, and fieldwork.

FIGURE 4

In the module "Stratification and Biodiversity in Pennsylvania's Northeastern Deciduous Forest," students examine the climate zones of the world, then analyze a climatograph of data from a northeastern deciduous forest. This module was authored by Pennsylvania high school teacher Elizabeth A. Aaron and Timothy Dugan, a service forester for the state of Pennsylvania Department of Conservation and Natural Resources (DCNR).

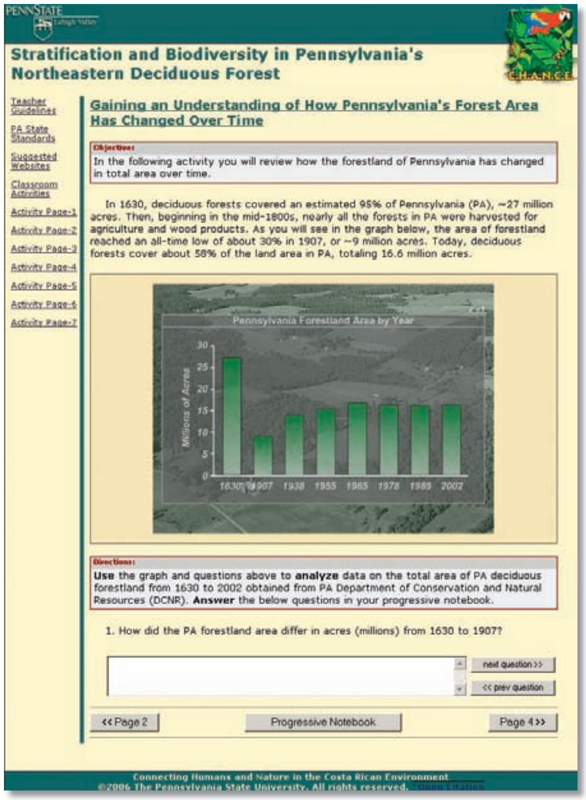


Examples of Modules

In the module titled "The Biology and Plight of the Leatherback" (Figure 1, p. 49), students act as researchers who work for Asociación ANAI and examine the life cycle, range, and nesting habits of Leatherback sea turtles. Students collect data on selected abiotic, environmental beach factors that affect the incubation temperature of turtle nests. Using real data taken from the conservation group, students use a virtual field notebook to record precipitation, tide line, sand color, foliage cover, and the depth of the six nests (Figure 2). Their objective is to learn how each of these abiotic factors plays a role in setting the incubation temperature, which they later learn determines the gender variability of the nest. Students then predict the gender of the eggs (males, females, or mixed) in each nest based on their findings.

FIGURE 5

In the module "Stratification and Biodiversity in Pennsylvania's Northeastern Deciduous Forest," students examine how Pennsylvania's forest area has changed over time.



In these modules students answer increasingly difficult questions. These lower- to higher-level questions further their understanding and are the key to inquiry-based learning. As another example, after observing the abiotic environmental factors that affect nest temperature and turtle gender variability, students watch an animated depiction of what might happen when natural predators and man-made factors are introduced into the scenario. Students must consider what they now know about the biology (life cycle) and nesting of the Leatherback and use it to explain how nature and humans can negatively affect egg survival (Figure 3).

Another module is "Stratification and Biodiversity in Pennsylvania's Northeastern Deciduous Forest," which is based on research from local (Pennsylvania) ecosystems. After learning about the climate zones of the world and how temperature and precipitation play key roles in defining the type of trees found in the deciduous forest biome (Figure 4), students explore the forest layers. They then examine how the forested area of Pennsylvania has changed over time

FIGURE 6

Later in the Forest module, to gain a better understanding of current and future regeneration issues, students analyze the experimental design and data from The Pennsylvania Regeneration Study. The results paint a troublesome picture for the future of Pennsylvania's forests, pointing to an overpopulation of white-tailed deer impeding forest regeneration.

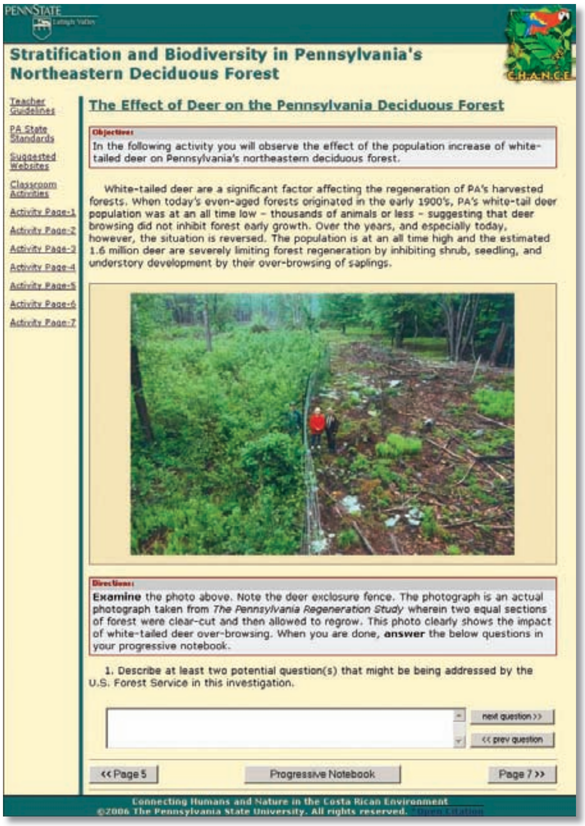
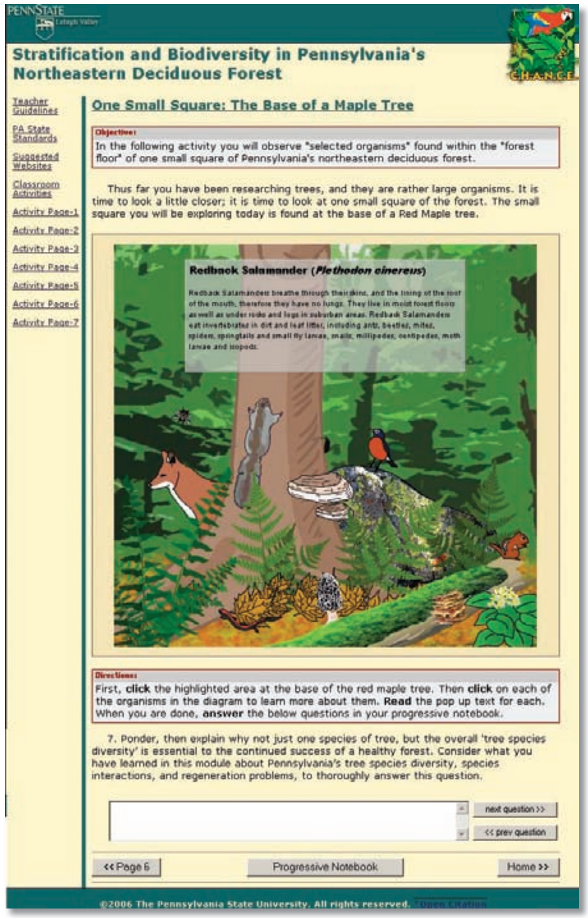


FIGURE 7

In the last portion of the Forest module, students examine overall species diversity at the bottom of a maple tree to better understand forest ecology, and the importance of a forest with a diversity of tree species.



using actual data gathered from the Pennsylvania Department of Conservation and Natural Resources (DCNR; Figure 5, p. 51). Acting as researchers, students then analyze data gathered from The Pennsylvania Regeneration Study wherein two equal sections of forest were clear-cut and then allowed to regrow (Figure 6). By working through an actual experiment, they learn that Pennsylvania's forests are largely even-aged, tree species composition is changing, forest regeneration is lacking, and deer are the key factors negatively affecting the successful regrowth of Pennsylvania's clear-cut forests.

By observing and studying selected organisms found at the base of a maple tree within the forest floor of Pennsylvania's deciduous forest, students think about diversity and how each of the organisms mentioned depend on the maple tree for survival. They are then asked to explain why not just one species of tree, but the overall "tree species diversity" is essential to the continued success of a healthy forest. Students must consider what they have learned in this module about Pennsylvania's tree species diversity, species interactions, and regeneration problems to answer this question (Figure 7).

Completed modules to date include the two mentioned above and four others concerning invasive species in Pennsylvania; raptor migration; and sea turtle hatchling nesting and orientation. Modules in the storyboard stage include topics on global warming, watershed restoration, waste disposal and pollution, and the newest technology in electricity production —burning culm (the main waste product of coal incineration).

The CHANCE modules are purposefully designed to be more engaging and interactive than a textbook by allowing students to "learn how things work" by using authentic research data.

Using authentic data

The CHANCE inquiry-based research module helps students make the connection between inquiry processes and the products that result from inquiry, such as theories, models, and explanations (Reiser et al. 2001, p. 264) and allows students to move from lower- to higher-level questions to further their understanding (Anderson and Krathwohl 2001). All CHANCE modules translate field work in a way that allows students to explore, observe, question, hypothesize, manipulate, analyze, and critically think about real data and information from accredited research programs around the world.

The CHANCE modules are purposefully designed to be more engaging and interactive than a textbook by allowing students to "learn how things work" by using authentic research data. These modules provide images and text that lead students through an interpretation of ecological principles. To assess if the use of CHANCE research modules enhances student learning of core biological concepts and required Pennsylvania Environmental and Ecological Standards, a research plan is currently underway to develop and orchestrate the use of standardized assessment tools before and after module use in selected Pennsylvania high school classrooms. ■

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Author's note

This year for the first time, teachers from outside of Pennsylvania are encouraged to apply to participate in the CHANCE program. To reach the largest number of secondary students, completed CHANCE modules are showcased on both PDE and PSU websites, and are freely available to anyone teaching high school biology or environmental science. Dialogue among educators is encouraged, and teachers can contact both the module authors and their research mentors via direct links found on the website. CHANCE participants also lead workshops and present at conferences on the use of their modules.

The CHANCE modules are accessible at *https://roycercenter.cwc.psu.edu/CHANCE*. For more information on CHANCE itself or to apply to participate in this program, see *www.lv.psu.edu/jxm57/explore/costarica2007* or e-mail Jacqueline McLaughlin at *JShea@psu.edu*.

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