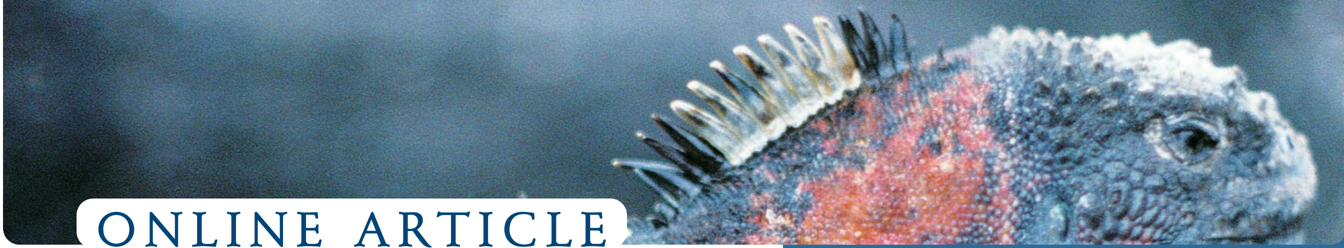

ONLINE ARTICLE

The CHANCE Program

Promoting Learning for Teachers & Students via Experience & Inquiry

Jacqueline S. McLaughlin

Today's high school students and biology teachers alike face challenges arising from constantly-changing environments. From global warming to species reduction to energy policy, the issues our students will face will have immediate and long-lasting implications. As citizens, business people, voters and even policy-makers, they will need to make thoughtful decisions based on a solid scientific understanding of conservation biology. At the same time, biology teachers are charged with achieving legislated standards, including biological science standards, within their public school systems. In Pennsylvania, for example, specific environmental science and ecology outcomes have been set for high school students (http://www.pde.state.pa.us/env_eco/site). With the passage of these environmental and ecology standards, school districts in Pennsylvania are re-aligning the curriculum. These state standards are aligned with the *National Science Education Standards* (see Table 1 and http://books.nap.edu/html/nses), and thus the biological principles integral to Pennsylvania's desired outcomes–such as trophic levels, species diversity, and inquiry-based data gathering and analysis–are addressed to some extent by biology teachers nationwide. Indeed, educators everywhere are being asked to modify or develop new lesson plans, and are looking for ways to make the standards "come alive" in the minds of their students. Within this scenario, teachers must prepare students for "real-world" challenges while equipping them to meet legislated standards.

One program that brings real-world scientific research into the classroom via technology is CHANCE–Connecting Humans and Nature in the Costa Rican Environment. This two-year old program transforms teachers into field researchers, who then translate their experiences to research-based Internet "modules" that bring the experience to the classroom (the modules can be accessed at https://roycenter.cwc.psu.edu/CHANCE). By using a field course inquiry-based learning model, shown to be effective in enhancing student comprehension, the modules help teachers create hands-on, research-based activities that bring scientific principles to life. CHANCE was designed to address the needs of school districts across Pennsylvania, and indeed the Pennsyvania Department of Education (PDE) now recommends the use of CHANCE modules as a way of helping high school students meet state standards in environmental science and ecology. However, since teachers in every state must meet similar standards, the CHANCE program provides a viable framework for renewing high school biology education nationwide.

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Table 1. Comparison of Pennsylvania and National Science Education Standards

SCIENTIFIC CONCEPT	PENNSYLVANIA DEPARTMENT OF EDUCATION	*NATIONAL SCIENCE EDUCATION STANDARDS*
Trophic Levels	Environment and Ecology Standards, 4.6.10 – Ecosystems and their Interactions: *Explain trophic levels.*	Life Science Content Standard (9-12) C –The Interdependence of Organisms: *Energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers.*
Species Diversity	Environment and Ecology Standards, 4.7.10 – Threatened, Endangered, and Extinct Species: *Explain the significance of diversity in ecosystems.*	Life Science Content Standard (9-12) C – The Interdependence of Organisms: *Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.*

The Genesis of CHANCE

At its core, the CHANCE program unites two organizational goals for their common benefit. As Pennsylvania's No Child Left Behind legislation defined competencies for environmental science and ecology, there was an increased need within the state for professional development programs that focused on enhancing teacher and student performance. At the same time, I had gathered data that strongly supported the value of experiential and inquiry-based pedagogy in teaching numerous undergraduate field courses focusing on biodiversity, environmental science and conservation biology (Zervanos & McLaughlin, 2003; McLaughlin, 2005; McLaughlin & Johnson, 2005, accepted for publication).

Specifically, this data measured student performance in three consecutive college-level courses in Costa Rica, each of which used a "field course experiential learning model" consisting of three components: pre-trip, trip, and post-trip. Using a combination of embedded assessment tools (journal analysis, surveys, and direct-response), we examined:

- the extent to which students demonstrated the ability to apply pre-trip learning in a field setting
- the extent to which specific learning experiences in the field contributed to gains across specified biology knowledge domains
- the ability to elaborate on field observations within a theoretical framework.

The results showed that the model contributed to significant student learning gains. An analysis of field journals found that students made gains in their understanding of conservation biology, and that these gains were consistent with cognitive process dimensions of understanding and applying (Anderson & Krathwohl, 2001). In addition, the data also indicated an unanticipated result: In these journal entries, the majority of students (88%) made unprompted statements about how the experience influenced them to behave more responsibly with respect to environmental issues as related to conservation practices. Finally, student post-trip surveys suggested that students were likely to engage in behaviors of environmental advocacy.

As a testament (of sorts) to Leopold's (2004) conceptualization that people fail to understand the interactions between man and environment because they live a "buffered" existence, the undergraduate students in these three courses appeared to be better able to understand man's negative impact upon the environment as a result of experiences they had had in the field.

But alas, most environmental education at the secondary level occurs inside classroom walls. Teacher education focuses on classroom or laboratory activities, with little emphasis upon preparing and leading field experiences. The goal envisioned for CHANCE was to use the proven "field course experiential model" to equip teachers with the pedagogical tools to lead experiential and/or inquiry-based activities in areas that would foster their own students' core competencies. By exposing teachers to the experiential and inquiry-based learning model, they experience first-hand its classroom implications. In turn, CHANCE teachers learn to adapt the model for their own use–by creating experiential- and inquiry-based lessons and virtual Web modules (described later in this article).

Now in its third year, CHANCE is a coordinated effort and partnership between the Penn State Lehigh Valley (PSULV) and the PDE, and works closely with conservation sites and established researchers/organizations/academic institutions in Pennsylvania and around the world (including the Pennsylvania Department of Conservation and Natural Resources [DCNR]; Hawk Mountain Sanctuary; The National University of Costa Rica; the Caribbean Conservation Cooperation [CCC], Duke University, and others). CHANCE's goals are two-fold:

- Engage teachers in the types of in-the-field learning activities they will be encouraged to create for their students.
- Establish a teacher-resource clearinghouse for inquiry-based, virtual Web lessons to teach envi-

ronmental science, ecology, and conservation biology as they relate to the real world and the mandated state standards.

The second goal ensures a cascading effect. CHANCE teachers, upon their return to the U.S., produce and publish (on the Web) their own inquiry-based, research-oriented module, which is then posted online and made available to high school educators for use within classrooms nationwide.

The CHANCE Difference

Both environmental concerns and educational standards increasingly dominate public policy decisions—locally, nationally, and internationally. As educators struggle to find ways to implement federally mandated performance-based curricula without sacrificing excitement and creativity, the subject at hand—the natural world—faces unprecedented struggles of its own.

One of the most serious threats to the natural world is loss of biodiversity at all three levels—ecosystem, species, and genetic (Wilson, 1992; Pimm et al., 1995; Sala et al., 2000; Brook et al., 2003; McKee et al., 2004; Pounds & Puschendorf, 2004). According to the *World Atlas of Biodiversity: Earth's Living Resources for the 21st Century* released by the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) in August 2002, during the past 150 years, humans have directly impacted and altered close to 47% of the global land area. Wilson (2002) provides an equally ominous projection, asserting that if the decision were taken today to freeze all conservation efforts at their current levels while allowing the same rates of deforestation and other forms of environmental destruction to continue, at least one-fifth of the current species levels of plants and animals would be gone or committed to early extinction by 2030.

Public policy protections are threatened as well. The current administration contends that the 1973 Endangered Species Act has imposed hardships on developers and others while failing to restore healthy populations of wildlife, and it is pushing to revamp the act. At any rate, diminished attention to species diversity is to be expected due to reduced financial resources (the administration's recently proposed budget calls for a $3-million reduction [4.6%] in funding of Fish and Wildlife's endangered species programs).

The unfortunate result of these converging truths is that biology teachers must prepare students not only to meet performance benchmarks, but also to function as residents of a world threatened by members of its own species—man. Adding to the challenge, experts argue, is the fact that students today are estranged from the natural world. Their "buffered" existence increasingly takes place within human-built environments or techno-ecosystems (Naveh, 1982), while their main exposure to other organisms takes place within the unnatural confines of zoos, aquariums, and/or (even more remotely) in color-coded diagrammatic pictures and figures in dry textbooks (which most appear to be struggling to read) and Web sites.

The multi-faceted modern challenge of biology teaching calls for pedagogical methods offering multi-faceted results. Fortunately, CHANCE offers potential equal to this challenge. Numerous studies in a wide range of school districts nationwide have shown that inquiry-based modes of active (as opposed to passive) learning enhance performance (Keys & Bryan, 2001; Gibson & Chase, 2002; Windschitl, 2003; Harlen, 2004). What CHANCE adds to this model is yet a new facet: enhanced levels of personal involvement by the teacher and student using experiential and/or inquiry-based opportunities—involvement with strong potential to last a lifetime.

Importance of the Three-Step Model

The strength of the CHANCE program stems from its use of the three-step "field course experiential learning model," which can be defined roughly as 1) preparation, 2) experience, and 3) synthesis. This model facilitates critical thinking and illustrates the scientific process—inquiry—in action. As a result, pre-trip (preparation) assignments don't exist in a void; they inform an anticipated experience and elicit inquiry. Likewise, field work (experience) is conducted by teachers (who become student-field researchers) who have become intimately familiar with the environment. Hands-on/minds-on work in the "field" is integral to the CHANCE course and its learning model. Facts gathered during the pre-trip stage are made "real" when manifested in nature. These manifestations then illuminate post-trip analysis—providing the "hard data" from which learning is synthesized. Assessments taken at each stage provide insight into learning and generate data useful in refining pre-trip, trip, post-trip activities for future use. In particular, field journals allow learners to synthesize and reflect upon their daily experiences—be they scientific, political, cultural or personal.

Preparation

To get a better idea of the model's functionality, consider its application to the 2004 CHANCE Costa Rica course for Pennsylvania secondary education science teachers and pre-service teachers. During the pre-trip stage, each teacher had to complete Web-based activities and research that provided essential background knowledge pertaining to his/her upcoming field work in Costa Rica. Additionally, since all teachers are required to lead a 30-minute presentation in the field followed by a group discussion on a related topic (specifically one that directly pertains to performance standards), presentation topics must be identified and researched during this stage of the course.

Experience

During the three-week Costa Rica trip, CHANCE teachers performed daily research-based field work in areas of conservation biology, supplemented with real-world ecosystem exploration, peer presentations and discussions, and species assignments. Among the venues visited were the Caribbean Conservation Corporation's (CCC) John H. Phipps Biological Field Station in Tortuguero, the Asociación ANAI Field Station in Gandoca/Manzanillo, and the lush tropical forests of La Selva Biological Station managed by the Organization of Tropical Studies (OTS).

To maximize the field experience, teachers were required to maintain a daily journal, attend daily research-based programs/presentations, and record and report all data gathered from daily research activities (such as gathering data on sea turtle nesting, hatchling migration, rainforest productivity, global warming, and bird population density; see http://www.lv.psu.edu/jxm57/explore/costarica2006/outline.html).

For many teachers, field experience literally animates formerly two-dimensional concepts:

> *... you could really see the difference between a cloud forest and a lowland tropical forest. I think that visiting and hiking through these different areas impacted my learning of Costa Rican ecosystems...When I did my presentation, I loved the fact that I was able to relate back to places we had already been.*
>
> – Pamela Yerkes

Synthesis

Back home, the post-trip stage consisted of reflective activities and Web-based assignments that encouraged the integration and application of key concepts learned–in particular, the creation of an interactive Web-based lesson module centered on their topic of interest. For teachers and future teachers, a significant part of the "synthesis" stage is devoted to translating the principles of experiential learning to their own classrooms.

Taking CHANCE into the Classroom

With my undergraduate students, the data showed that learning increases relative to experiential and/or inquiry-based learning approaches in which students construct their own knowledge (Table 2). Similarly, teachers who had completed the Costa Rica program indicated that it was difficult to imagine teaching environmental science, ecology, and/or conservation biology without incorporating some field experience into their courses. They were more likely to guide student research, to oversee students working in groups, to present "hands-on" classroom activities, and to engage students in field experiences (Tables 3 and 4). Moreover, they looked forward to developing interactive Web-based modules based on their fieldwork.

Perhaps most importantly, teachers and future teachers learn firsthand how work in the field serves as a strong catalyst for the formation of a "bond" with the environment that is the hallmark of CHANCE. As one teacher explained in a post-trip assessment:

> *I believe that humans have a natural instinct to protect what they love. When we learn about something, we can intellectualize about it, but we can only love something that we have experienced. In Costa Rica, I had an opportunity to ... fall in love with the biodiversity that exists in the rainforests, that which I had only... learned about from books.*
>
> – Susan Baranek

For many, field work generates a *eureka!* moment, a unique instance when learning and knowing naturally merge:

> *The experiential learning that occurred in [Costa Rica] is the best training to teach conservation biology. It's so much easier to be passionate about a topic when you've experienced firsthand the effects of not doing what's environmentally responsible ...*

Table 2. Student Gains Using Field Course Experiential Learning Model

EMBEDDED ASSESSMENT METHOD	PERFORMANCE MEASURED	FINDINGS
Field journal entries (unstructured assignment)	Application of scientific theory to field experience	94% provided evidence of comprehension-level learning gains; 39% demonstrated application-level gains*
Post-trip assignment (structured activity)	Ability to relate field experience to assigned readings	97% demonstrated application-level gains*
Student Assessment of Learning Gains (SALG) Survey	Student self-perception of specific knowledge and skill outcomes in biodiversity and conservation biology	Students consistently stated that they made high gains in a wide range of specific knowledge domains.

Note: Results are based on an analysis of 62 undergraduate students over three trips to Costa Rica (McLaughlin & Johnson, 2005, accepted for publication); detailed data available from author upon request.

*This rubric traced the students' ability to move from "knowledge" to "comprehension" to "application" cognitive learning levels using examples drawn from their experiences.

Table 3. Change in mean from pre-trip and post-trip assessment responses.

	PRE-TRIP	C.I.	POST-TRIP
How likely are you to guide students in classroom research to learn conservation biology concepts?	2.53	2.18 - 2.89	3.27
How likely are you to use groups to allow students to discover and understand difficult biological concepts?	2.40	2.05 - 2.75	3.47
How likely are you to lecture to students to help them discover and understand difficult biological concepts?	3.00	2.58 - 3.42	1.87

* Teachers were asked to judge the likeliness of their leading a specific classroom activity as either "not at all," "not very likely," "somewhat likely," and "very likely" for both pre- and post-trip segments of CHANCE. The table shows the change in mean from pre- to post-trip as well as the pre-trip confidence interval (C.I.). Data was collected over the course of two CHANCE programs which included 28 teachers.

Table 4. Differences in response percentages between pre and post trip data.

		PRE	POST
How often do you engage your students in field experiences to improve their UNDERSTANDING OF CONSERVATION BIOLOGY CONCEPTS?	0 to 2 3+	85% 15%	41% 59%
How often do you engage your students in field experiences to improve their understanding of environmental science?	0 to 2 3+	73% 27%	38% 62%
How often do you use hands-on activities in class to improve students' understanding of conservation biology?	0 to 2 3+	87% 13%	31% 69%
How often do you use hands-on activities in class to improve students' understanding of environmental science concepts?	0 to 2 3+	69% 31%	23% 77%

* Teachers were asked to share the number of times they conducted a specific activity. Choices included "never," "one to two times per grading period," "three to five times per grading period," and "more than times per grading period." The table shows the change in response percentages between pre- and post-trip data. Data was collected over the course of two CHANCE programs which included 28 teachers. The Cross Tab test showed the results were statistically significant in all cases.

... Adrenaline rush: I still feel it every time I recollect the trip to someone, the moment the leatherback hatchlings poked their heads through the sand at Hatchery A.

– Jeanne Gochnauer

Another benefit of fieldwork is its metaphorical distance from "regular" life:

At the onset of the trip, I had packed many things I didn't need along with some things that were absolutely necessary. Some things ... got given away or left behind. When room opened up in my suitcase, I was able to put in things from Costa Rica that were useful and authentic to the situations. One never knows how much one can learn until the mind opens and all hindrances to truthful, experiential learning are purged.

– Sarah Kepner

Unfortunately, the high cost of conducting fieldwork in distant locations means most educators must adapt the CHANCE model to fit their unique learning environments—and incorporate "field" resources closer to home. CHANCE teachers, therefore, are encouraged to apply the three-step model to classroom lessons and to establish frameworks for preparation, experience, and synthesis components.

Teachers soon find that even perceived restrictions (such as geographic locale or curriculum area) serve to reinforce real-world applicability of the CHANCE model, as returning participants adapt their experiences to the classroom:

I use the presentation topics [from CHANCE field presentations] as a guide to introduce these new concepts, then [my students and I] go out to Milton Hershey Campus and find examples to explain these ideas. The students make connections that amaze me, since this is really their first taste of environmental science.

My typical biology classroom is more centered on ongoing projects (example: stream quality), monitoring and the presentation of data by students [who] have to explain their results and plan further extensions.

We are developing and improving, with the help of students from various classes (Vocational Agriculture, AP biology, and biology), our outdoor environmental education center.

Creating & Using CHANCE Modules

One of the most innovative elements of the CHANCE program takes place during the post-trip segment: the creation of Web-based "modules" related to their specific topic of interest. By working in tandem with field researchers, each teacher must map-out an interactive Web-based module that promotes hands-on/minds-on classroom environmental and/or ecology research experiences likely to result in enhanced awareness of and concern for ethics and conservation. This hands-on/minds-on approach is particularly attractive to secondary students, most of whom enjoy the "virtual" experiences today's technology affords. In addition, it provides a needed supplement to textbook assignments students often fail to comprehend. Best of all, CHANCE modules promote active learning by providing opportunities for students to participate as individuals directing their own learning process.

During a post-trip day long workshop held at PSULV, CHANCE teachers are trained in the use and development of inquiry-based, research-oriented Web modules (including storyboarding, using templates, and working with PSU instructional design staff). During this time, teachers outline their initial storyboards. Each teacher's module is subsequently completed under supervision–with my assistance and that of a research mentor who is a field expert on the specific topic covered. For example, the module titled "Sea Turtle Hatchling Orientation from Nest to Ocean" was authored by the late high school teacher Dr. Robert C. Kotran and Dr. Kenneth J. Lohmann, a biology professor and expert on sea turtle conservation at the University of North Carolina at Chapel Hill. "Stratification and Biodiversity in Pennsylvania's Northeastern Deciduous Forest" was authored by pre-service high school teacher Elizabeth A. Aaron and Timothy Dugan, a service forester for the state of Pennsylvania Department of Conservation and Natural Resources (DCNR).

Each module is created to maximize classroom functionality. In addition to an animated research scenario (Figure 2), each includes links to teacher guidelines, state standards addressed, suggested Web sites, and classroom activities. Unique to these interactive modules is CHANCE's copyrighted "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.

Figure 1.
The CHANCE (Connecting Humans and Nature in Costa Rican Environment) homepage showcasing partners, program description, fellows, and CHANCE modules.

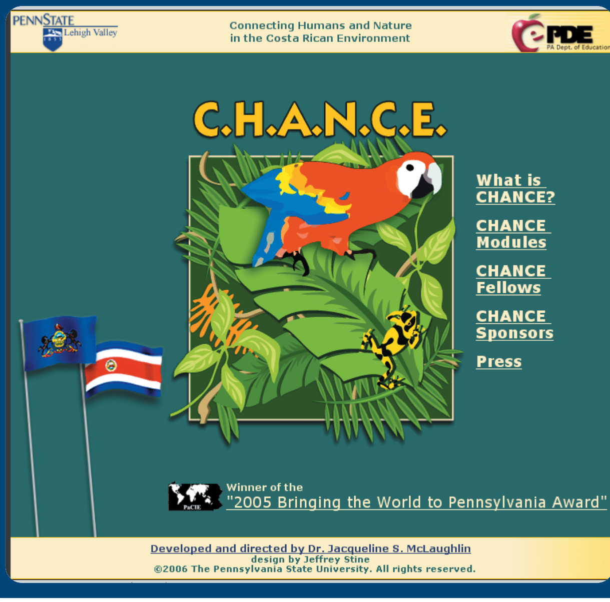


Figure 2.
In the module "Sea Turtle Hatchling Orientation from Nest to Ocean," students first explore the possible environmental cues (dark silhouettes, beach slope, and ambient light) that a hatchling might use to find its way to the sea.

For instance, in the above module on sea turtle hatchling orientation and navigation, students place hatchlings in an "Orientation Arena" and expose them to different combinations of silhouette height, degree of slope, and light. Using real data which is then simulated, each hatchling is tethered to a central post and then released in the arena's center so that it can crawl in any direction it chooses (Figure 3). Students observe the hatchlings, collect data, plot "scatterplots," and then determine whether the turtles' direction was random or oriented in order to support which environmental cue may be involved in hatchling directionality to the sea.

As another example, after observing that both slope and light appear to contribute to hatchling orientation, students are shown an animated depiction—from the hatchling's point of view—of what might happen when environmental pollution is introduced into the scenario. Students must consider what they now know about hatchling orientation and use it to explain how pollution impacts hatchling survival (Figure 4).

As students must be able to move from lower- to higher-level questions to further their understanding (Anderson & Krathwohl, 2001), the inquiry-based module provides a rich learning opportunity by helping them 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). All CHANCE modules translate fieldwork in a way that allows students, in the classroom or at home, to explore, observe, question, hypothesize, manipulate, and/or analyze and critically think about real data/information from accredited research programs around the world (https://royercenter.cwc.psu.edu/CHANCE).

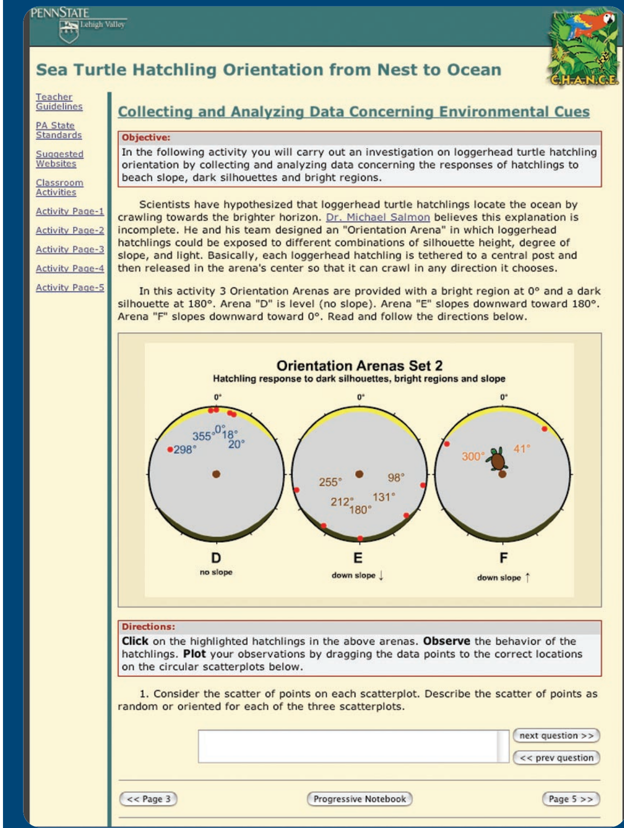
To initiate and maintain a cascade effect, and thus reach the largest number of secondary students, completed CHANCE modules are showcased on both PDE and PSU Web sites, and are freely available to anyone teaching high school biology or environmental science around the Commonwealth, the nation, and ultimately Costa Rica. Dialogue among educators is encouraged, and teachers can contact both the module authors and their research mentors via direct links. Future plans include translating these modules into Spanish for both English as a second or foreign language (ESL) students in Pennsylvania and across the United States. CHANCE teachers also lead workshops and present at conferences on the use of their modules.

The Future of CHANCE

The CHANCE program is being assessed to provide information for continuous improvement of the course model and on how the design is contributing to teacher development and student learning. The goals of the assessment are:

- to evaluate the extent to which the planned course learning activities are contributing to teachers' gains in environmental science, ecology, and conservation biology knowledge
- to evaluate the extent to which participating in experiential and inquiry-based learning programs prepares teachers to design experiential and inquiry-based learning experiences in classrooms they lead
- to measure the extent to which teachers' subsequent teaching behaviors change as evidenced by their planned learning experiences

Figure 3.
Later in the module, students collect, record, and analyze real data—simulated here to help them research the behavior of turtle hatchlings in response to dark silhouettes, slope, and bright light.



- to measure the extent the modules enhance the learning of environmental science and ecology content within the required PA state standards by PA high school students. (This year for the first time, teachers from outside Pennsylvania are encouraged to apply to participate in the CHANCE program.).

The assessment plan is embedded into the field experience through rubric-driven evaluations of written work including field journals, a species assignment, and responses to open-ended questions on a post-trip evaluation. These embedded assessments are supplemented by pre- and post-trip surveys that examine teaching behaviors before and after the experience, and a post-trip survey that examines how teachers' perceived specific field experiences contributed to specific learning gains in environmental science, ecology, and conservation biology.

For more information on CHANCE itself or to apply to participate in this program, see www.lv.psu.edu/jxm57/explore/costarica2006 or e-mail Jacqueline McLaughlin at JShea@psu.edu. The CHANCE modules are freely assessable at https://royercenter.cwc.psu.edu/CHANCE.

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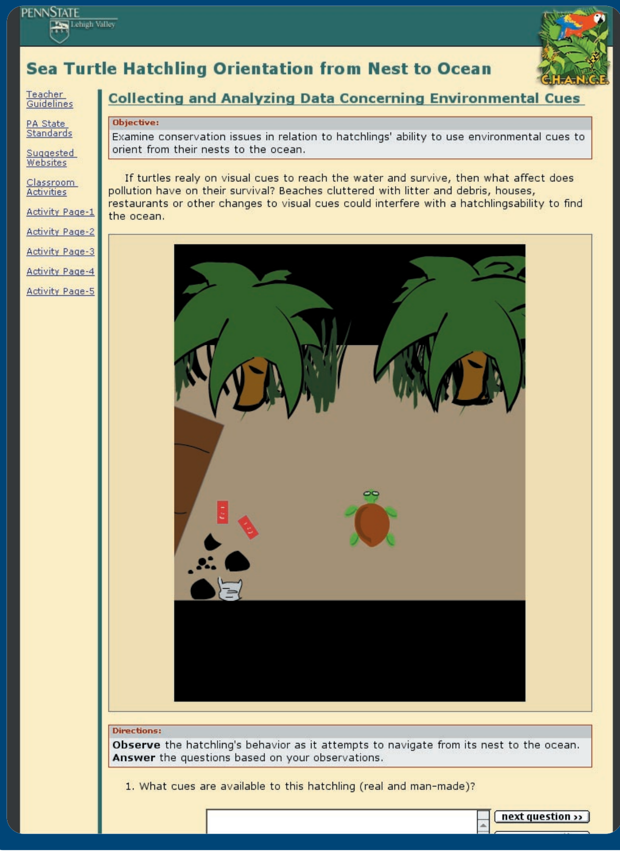
Figure 4.
In the last portion of the module, students examine conservation issues (environmental pollution) in relation to a turtle hatchling's ability to orient from the nest to the ocean, and therefore its chance for survival.



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