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From Presentation to Programming

Doing Something Different, Not the Same Thing Differently

Rather than using MicroWorlds just to do a presentation on dolphins, students use MicroWorlds to simulate a highly realistic ocean ecosystem complete with dolphins.

By Cathleen Galas

"Would you rather that children learn to play the piano, or learn to play the stereo?" asks Mitchel Resnick of the Media Laboratory at the Massachusetts Institute of Technology. "The stereo has many attractions: It is easier to play, and it provides immediate access to a wide range of music. However, 'ease of use' should not be the only criterion. Playing the piano can be a much richer experience. By learning to play the piano, children learn to express themselves in new ways. They can continue to learn and develop over time, adding new complexity as they improve. In doing so, they are more likely to learn more about the deep structures of music" (Resnick, Bruckman, & Martin, 1996).

Doing the Same Things Differently

In classrooms all over the country, overburdened teachers are rushing to provide "stereo" instruction to children. In other words, they are under the impression that children who use multimedia software on computers—rather than create their own materials—will learn more and learn better. Such instruction has been touted as necessary to help students move into the 21st century with the right technological skills.

Multimedia software may indeed allow students to present information. It is easy to use, and it can help students produce exciting presentations quickly and beautifully. Such programs offer a rich assortment of tools that help students present their learning; graphics, photographs, audio, and even video formats all enhance their presentations. Students can make their reports come to life with outstanding multimedia capabilities.

These presentations, however, are still presentations. Using these multimedia tools, students are still just learning to play the stereo. For example, a stereo presentation on dolphins might show cards with images and information, and even hypertext buttons with dolphin sounds. These cards show the information researched and read by students. Children are doing the same things that students have done for many years—they're just doing them a different way. Their presentations are more exciting, motivating, and interesting because of the added features, but they are still just presentations.

Doing Different Things: Constructivist Technology

When students learn to play the piano, they use the instrument as a tool to create their own music. They spend time learning about music and eventually learn to manipulate musical structures, interacting with the piano and the music. Using a similar process—"tool" computer software—students can build and manipulate, rather than just present, and thus learn to play the piano. They use software to create their own environments that can be manipulated and changed.

For example, using MicroWorlds 2.0, which is based on the Logo programming language, children have built an ocean ecosystem complete with dolphins. They have been able to program "what if" situations and rules by which the ecosystem operates. If the food supply changes, so does the dolphin population. In this way, one group of students studied protective adaptative behaviors in marine animals. Dolphins threatened by sharks protected themselves and their offspring in unique ways (see Figure 1). These simulations of dolphins required conceptual

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understanding, higher level thinking skills, and the ability to interact with the system according to its own special rules. This learning by building personal understanding is the basic tenet of constructivist philosophy.

An Instructional Paradigm for Doing Things Differently

Project-by-design programs, which are in the forefront of educational research worldwide and readily funded in the United States by the National Science Foundation (NSF), use technological investigative methods to help children learn to play the piano. These projects have similar design features: choice of topics, group collaboration, long-term projects, and artifact production (usually a project, model, or simulation). Most are at the middle school or high school level.

Project-Based Learning Environment

At Seeds University Elementary School, the laboratory school for the University of California at Los Angeles Graduate School of Education and Information Studies, students are working with computers and technology in a multiyear NSF project by design. Yasmin Kafai is the principal investigator; she is aided by graduate students Sue Marshall and Cynthia Ching and classroom science teacher Cathleen Galas. Using MicroWorlds, we have been working with fourth, fifth, and sixth graders to provide conceptual science explorations and experiences through student constructions of collaborative and interactive technology projects.

Overview of Project

When a project begins, students learn not only basic Logo programming concepts used in MicroWorlds 2.0 but also aspects of software design. Students get their first programming practice in teams. They learn how to use graphics tools, and how and why buttons are used to go a new page. They also learn the difference between using buttons or turtles, and that single-line instructions can be displayed when a program user connects with a turtle or button. Students practice creating text boxes and learn the basic commands to control the turtle. Finally, they learn that procedures are necessary to make more than one thing happen at the same time. Students are thus motivated to learn to make the following simple two-part procedure:

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Procedure example:
to _________ (run)
end
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More advanced programming occurs as students develop a need to know. They ask the teacher, other adults, or peers, or they check the available manuals to learn advanced programming techniques. For example, if a student wishes to show a change in the food supply, then he or she learns to program a "slider" that moves in either direction along the same axis to show an increase or decrease in the food supply. The programmer then writes in the rules, the "what ifs" that result if the

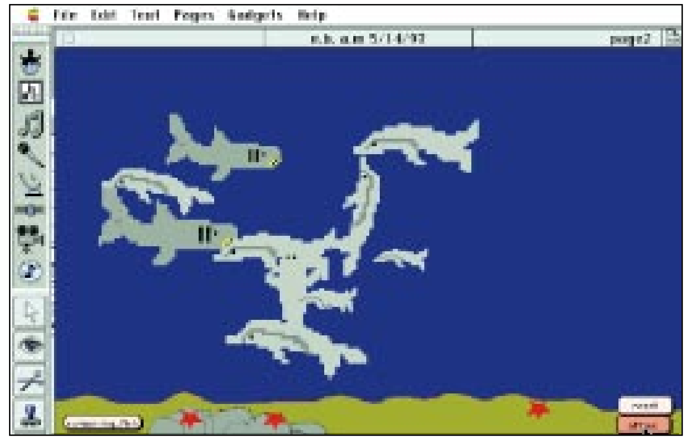

Figure 1. This screen illustrates a dolphin pod defense. Some dolphins move vertically up and down while others circle to keep the young dolphins close to the group. The tactic is confusing to the sharks.

supply changes. Users can move the slider to discover what happens in various food situations, thus building their understanding of food web relationships.

Second, a specific topic is introduced. As a group, students generate many "wonder"questions that can be refined into the students' personal "driving" questions of inquiry. Elliot Soloway, professor at the University of Michigan's Foundations of Science, uses this term to define deep, personally relevant inquiry questions that are suited for long-term, project-based science projects. Students fill out applications for team jobs and are assigned to teams of three to five students. Each team has a computer and an adjoining work area where planning boards and materials are available; here they start mapping out their ideas and timelines for their projects. Collaborative team-building activities help students work effectively in unison to construct their projects. Ongoing team-counseling activities help to resolve conflicts and mediate differences in individual student agendas.

Learning activities are large-group, small-group, and independent. Students may participate in some activities or experiments that the teacher assigns, and they may also design their own experiments, investigations, or research. The student-centered design and on-demand learning aspects of the projects require considerable teacher flexibility in this model. The teacher must not only understand the topics but also act as an information provider, guide, and interpreter. Before the unit, I collected many Web addresses for oceanography and marine biology sites, and then made them available to students from our own classroom Web site. In addition to discussing our experiment results, we examined the research found on the Internet and discussed the e-mail responses from marine biologists who worked with each group.

Third, students brainstorm their wonder questions in oceanography and marine biology. Small groups then meet to discuss specific research interests. A clipboard is available for students to write lesson requests. The first items on the list of our most

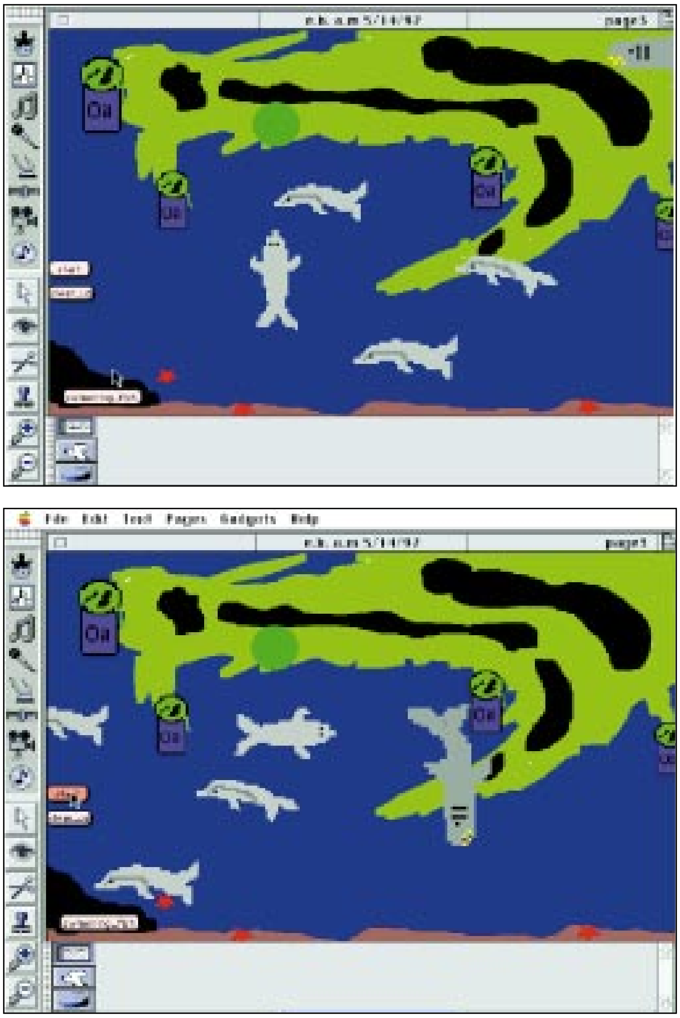

Figure 2. These screens show oil spilling into the ocean. The simulation shows dolphins ingesting the oil and the resulting toxic effects.

Figure 3. This simulation illustrates adaptive behaviors by showing clownfish safely swimming among sea anemones. The clownfish behavior attracts another fish, which believes the anemones to be safe. The fish is stung and eaten by one anemone.

recent marine biology unit were "food webs" and "how do animals adapt to different conditions in the oceans?" These request items coincided with my overarching goals for student learning, so I planned specific lessons on food webs and adaptation.

Teacher-centered required lessons on ecosystems and current events led into a series of lessons and discussions requested by students. For instance, some expressed interest in human behavior effects on ocean life in Santa Monica Bay and along the California coast, and the discussion led them to oppose the expansion of a salt mine in Baja California, Mexico, because it had been predicted the project would have negative effects on gray whales in the area. Student activists then began independent research on ways to protect the ocean environment. Several group projects, in fact, revealed environmental-protection concepts. One project even animated an oil spill, showing the ensuing death of marine life in the area (see Figure 2).

Some experiments and activities were hands-on, and some were virtual (largely those developed through Internet resources). We took a real field trip on a research vessel and conducted various experiments on the water and ocean floor, viewed plankton through microscopes, and carefully gathered marine specimens for discussion. Other real and virtual field trips allowed us to view marine habitats, discuss adaptations, and learn more about human impact on the ocean environment. The entire class virtually dissected squid, identified whales on video, reconstructed marine mammal bones, and visited ocean museums. Students also asked to clean the beach on one of our real ocean visits. One project created after this trip showed a littered beach with a "clean-it-up" button. When a user clicked on the button, a hand actively picked up all of the trash on the beach and deposited it in a beach trash can.

In the classroom, we used the Internet as one resource for information and interactivity. To set the stage in oceanography, we began with whole-class activities that acquainted students with the world's oceans, the water cycle, and the ocean floor. Small groups met to view ocean color from space via the Internet, completing ocean map activities online and discussing and coloring maps using current satellite information. An online current activity allowed students to track real-life drifter buoys to see the directions of ocean currents. Students also took a virtual ocean habitats tour courtesy of the Monterey Bay Aquarium, interacted with ocean maps that showed trenches and tectonic-plate movement, and played an online aquatic environment game. When one student brought in his tadpoles for the class to observe, the entire class met to discuss coming changes. We looked together at pictures, diagrams, and videos available on the Internet, and then posted Web sites for interested students to pursue. Some groups explored the whole frog project, and some decided to participate in the virtual interactive frog dissection. Whole-class lessons and activities were reserved for concepts that were important for all students. Activities were different for various groups, depending on their research ques-

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tions; some activities were optional for those who were interested.

Students also are designing software for both their own learning and an audience. During the unit, students must show their projects to their groups, the class, and younger students as part of a "usability study." These younger students use the computer projects and give feedback to each group on the software's ease of use, what they learned, and whether the older students are communicating the understandings and knowledge well. These "reality checks" help students evaluate their progress, their goals, and, ultimately, their own learning.

Students Designing Software

Students who design software simulations and models learn about science in a way that connects information more meaningfully. Learning *about* dolphins brings a deeper understanding than studying disconnected facts about the kinds of dolphins and their diets and habitats. When students learn about dolphins and have to build and connect those pieces of research into a computer ecosystem, they learn the interrelationships of the information. When they explore how temperature, food supply, and numbers of predators in the environment combine to affect the dolphins' existence, the students learn about systems in science at a conceptual level, because they must understand connections and relationships if they are to construct an accurate model. When they just present information, they do not demonstrate true understanding. They are simply recalling information they have read or heard.

One major difference in project-by-design science is that students pursue their research and work on a project during the unit itself and not as a culmination activity after a science unit. Therefore, as students participate in teacher-directed activities or pursue their own research interests, they continually apply concepts to the structure of their project. Students must explain how the information or new ideas—their evolving understandings—relate to their project.

Bridge to Their Future

In many schools, teachers are scrambling to use technology in their curriculum. To meet a perceived demand, software designers are giving away stereo software for teachers to use. It reminds me of an ancient Chinese proverb: "If you give a man a fish, he has food for a day; if you teach a man to fish, he has food for a lifetime." If we just give our students presentation software, then our students will eat for a day. When we teach our students the skills to construct high-level, connected, and conceptual understandings, they can build their own bridge to the 21st century.

As a result, we will not be doing the same things differently, we will be doing different things with our technology. We will be providing tools that bring different outcomes. We will teach our children to fish and to play the piano. They will never be hungry, for they will feed on their own abilities to learn what is necessary to cross the bridge into the next century. We can give our students "piano" software tools that we can learn to play together. We can act as guides in the learning process instead of all-knowing information givers. We can respond to student questions on demand and help students discover and understand through their own investigations. In this way, our students may feast on a variety of wondrous music of their own creation, consuming their own and their peers' bountiful harvests of understanding, masterfully tickling the ivory keys of technology to manipulate, model, and simulate problems and solutions in the next century. As futurist David Thornburg suggests, we as teachers can truly provide students the real tools of technology to cross the bridge to their future instead of our past. ■

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Reference

Resnick, M., Bruckman, A., & Martin, F. (1996). *Pianos not stereos: Creating computational construction kits* [Online]. Available: http://el.www.media.mit.edu/groups/el/papers/mres/pianos/pianos.html.

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