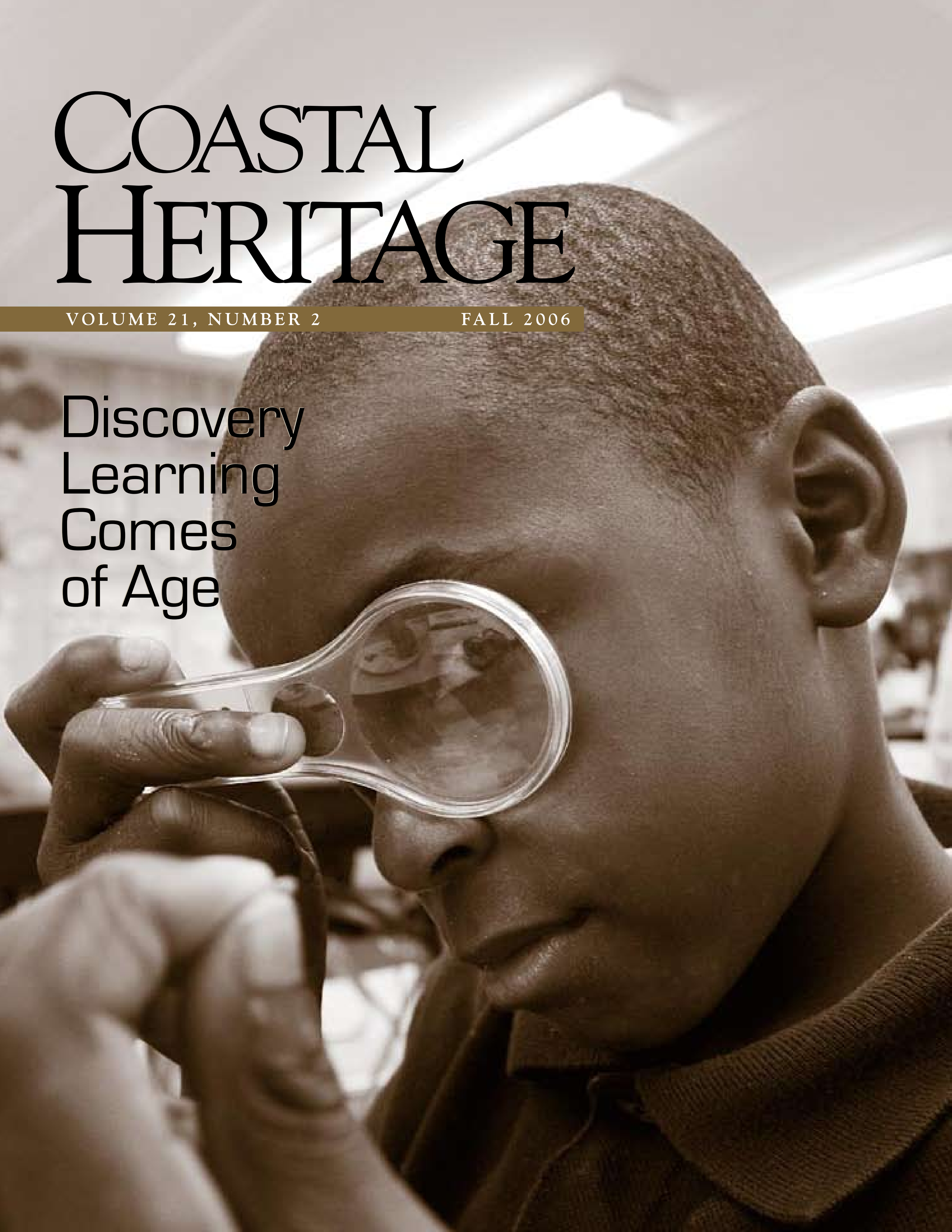


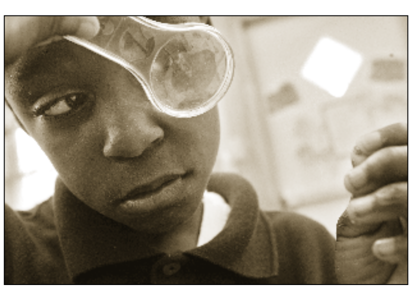
COASTAL HERITAGE

VOLUME 21, NUMBER 2 FALL 2006

Discovery Learning Comes of Age

CONTENTS

ON THE COVER: *Students are increasingly learning science through hands-on activities. Antonio Mitchell, a third-grader at St. Andrews School of Math and Science in Charleston, examines a piece of "mock rock" made from materials in a science-education kit.* **PHOTO/WADE SPEES**



Sea Grant
S.C. Sea Grant Consortium

Coastal Heritage is a quarterly publication of the S.C. Sea Grant Consortium, a university-based network supporting research, education, and outreach to conserve coastal resources and enhance economic opportunity for the people of South Carolina. Comments regarding this or future issues of ***Coastal Heritage*** are welcomed. Subscriptions are free upon request by contacting:

S.C. Sea Grant Consortium
287 Meeting Street
Charleston, S.C. 29401
phone: (843) 727-2078
e-mail: Annette.Dunmeyer@scseagrant.org

Executive Director
M. Richard DeVoe

Director of Communications
Susan Ferris Hill

Editor
John H. Tibbetts

Art Director
Carl Turner

SCIENCE MATTERS. *Christian Leprettre, a third-grader at St. Andrews School of Math and Science in Charleston, sorts and classifies materials from a "discovery-learning" kit. Careful observation is a crucial step in doing science.* PHOTO/WADE SPEES

Discovery Learning Comes of Age

Many teachers are struggling with "discovery learning," the strongest trend in science education. But help is on the way.

By John H. Tibbetts

Learning science is not easy. It takes patience, concentration, self-discipline—attributes that youngsters, naturally, have in limited supply.

American youth face an unprecedented challenge in science labs and classrooms. Distracted by cell phones, the Internet, TV, after-school jobs, and extracurricular activities, students are struggling to focus at a time when they're offered more intellectual freedom than ever. They are increasingly called upon to do science through hands-on activities such as lab and field investigations. This is called "discovery learning" or "inquiry learning."

The principle sounds simple: whenever possible, students should learn things for themselves.

Hands-on, discovery learning is the most effective way to teach science, says Paula Keener-Chavis, director of education programs for the NOAA Office of Ocean Exploration. "Students, for instance, can measure the growth of plants, plot results, and then report and compare those results. This process encourages children to discuss and learn from one another. Instead of just being a lecturer, the teacher facilitates learning."

More and more teachers are depending on science "kits" that include materials for experiments geared toward particular grade levels and state curriculum standards. The kits allow students to examine evidence in a hands-on way about the natural world and, to some degree, discover scientific processes on their own. Young people are encouraged to frame their own research questions, make observations, design and execute experiments in labs and in the field, gather and analyze data, and construct scientific arguments and explanations.

At the same time, though, it's getting more difficult to keep students' attention. "Young people today have problems with self-discipline, being able to stay on task," says Julie Cliff, who retired in June 2006 after 32 years as a marine-science and biology teacher at Wando High School in Mt. Pleasant.

That's why Margaret Spigner, a veteran marine-science teacher at West Ashley High School, steers her students toward hands-on investigations addressing real-world problems.

Her students examined a nearby development's impacts on a vegetated buffer zone around the high school's stormwater pond. Students also reestablished the water-quality buffer zone, created a platform for monitoring pond phytoplankton, and built a nature-walk platform over nearby wetlands.

"It's not just having them come into the lab and do something," says Spigner. "They're doing activities that affect the entire community, and they feel they've made a difference."

Her instructional approach, however, is unusual. She links hands-on experiments to problems that students can see in the world.

By contrast, many American teachers and students are fumbling discovery learning, education researchers say. U.S. teachers frequently are not connecting hands-on activities in classrooms, labs, and in the field with anything meaningful in their students' experiences—or even with the content of biology, physics, chemistry, geology, or other science disciplines. If done poorly, discovery learning, critics argue, can be an empty process, teaching little. And students are left bewildered in the process.

"Too many students are just learning bits and pieces of information," says Elizabeth Rogers, S.C. Sea Grant Consortium marine educator. "They don't have an opportunity to learn how those bits and pieces are tied to science and to their lives."

Where did discovery learning come from? Why are teachers having trouble with it?

Discovery learning began as a reaction to the science lectures of a generation ago. A traditional teacher would talk for the entire hour. Then the teacher would assign homework that called for memorizing facts, vocabulary, and formulas. Such old-fashioned techniques should be rejected because they're ineffective and turn many student learners away from science, reformers said.

During the 1990s, education researchers began developing discovery learning as a better way. Depending on

MOBILE CLASSROOM. ***After measuring a stormwater pond's dimensions, West Ashley High School biology students carry their "research vessel" back to storage. Teacher Margaret Spigner encourages her students to study real-world problems, such as a nearby development's impacts on this pond's buffer zone.*** **PHOTO/WADE SPEES**

grade level, teachers today use various degrees of inquiry learning—from highly structured, closely guided instruction via hands-on experiments to almost open-ended science discovery.

"A lot of inquiry can be guided step-by-step for very young children," says Linda Sinclair, state science consultant for the S.C. Department of Education. "Then as the student becomes more knowledgeable and skillful, a teacher's lesson can be less structured."

One problem, however, is that many teachers have not yet learned how to teach this way during a school year overfilled with science topics. After all, it's the most radical new pedagogical philosophy in K-12 science classes in generations.

"Inquiry learning is still relatively new," says S.C. Sea Grant Consortium researcher Leslie Sautter, a geologist at the College of Charleston and an author of marine-science curricula. "We shouldn't go back to relying just on textbooks. At the same time, teachers can't just jump from one style of instruction to another without more training and support."

Teachers need better professional-development programs in discovery learning, experts say. They also need more focused curriculum materials, smaller classes, fewer science topics to teach, and more lab time for experiments.

While teaching techniques are dramatically changing, public attitudes about science education are trapped in a bygone era. Many young Americans still don't realize the importance of succeeding in science and math classes. These "gatekeeper" subjects affect students' future opportunities in school and careers.

Without a strong background in high-school science and math, young people often flounder in post-secondary classes and later have fewer chances at high-paying jobs, which increasingly demand strong technical and analytical skills.

THE CRISIS IN SCIENCE EDUCATION

U.S. schools are inadvertently winnowing out young people capable of earning college degrees in science, technology, engineering, and math. The American educational system guides only the most gifted children toward science careers, and this could dampen our economy over time.

"We're not keeping enough children in the pipeline for science careers," says Meta Van Sickle, an education professor at the College of Charleston. "We've been very good at getting about three percent of our population to excel at math and science and to continue in the pipeline. Three percent is not enough, and that's why we're importing so many scientists and engineers."

In schools across the country, science education shows signs of decay. Too many parents have low expectations for their children, who avoid studying science because it's considered difficult or beyond the realm of traditional careers in their communities. Teachers are hampered by overstuffed textbooks and poorly designed curricula. And high schools serving lower-income neighborhoods typically don't offer advanced courses in science and math.

The number of U.S. citizens who receive college degrees in science and engineering has been dropping for years. By 2008, two million men and women in science-related fields are expected to retire, causing a shortfall of skilled workers, according to a 2005 report by the Business-Higher Education Forum, a national nonprofit membership organization of chief executives from business and higher education. Eroding investments in science, technology, and education are threatening the nation's economic competitiveness, industry groups warn.

During the 20th century, the United States commanded a global edge in science and technology in large part by attracting foreign scientists such as Albert Einstein and Enrico Fermi. America continues drawing exceptional scientists, engineers, and entrepreneurs from abroad. Foreign students fill ranks of U.S. graduate-level science and engineering programs, and many stay here to build careers and companies. High-tech enterprises such as Google, Yahoo, e-Bay, and Sun Microsystems were all founded or co-founded by foreign-born Americans.

Now, though, foreign scientists and graduate students are beginning to go elsewhere. They are working and studying in the European Union, Canada, and Scandinavian countries, which have taken steps to welcome exceptional talent. China and India have had success in drawing back their own top scientists.

The United States now must develop homegrown talent, recent studies assert. But American public schools don't have enough qualified science and math teachers to nourish the next generation. By the 2008-2009 school year—just two years off—at least

SPOT-CHECK. *Kile Taylor, a senior in Margaret Spigner's science-research class at West Ashley High School, checks salinity of pond water with a refractometer.* PHOTO/WADE SPEES

Where American students stand

America's young science students aren't keeping up with those in high-scoring countries overseas, particularly some in Asia.

U.S. fourth- and eighth-graders, according to the Trends in International Mathematics and Science Study (TIMSS) testing from 1995 to 2003, are competitive in science compared to their counterparts in some other advanced industrial nations. Even so, American students are trailing far behind youngsters in countries that could eventually challenge the United States in some cutting-edge scientific fields.

From 1995 to 2003, U.S. fourth-graders' science scores remained essentially unchanged. In 2003, they placed sixth among 25 nations. Yet scores in some Asian places (Singapore and Hong Kong) improved spectacularly. And some relatively poor countries (Hungary and Latvia) also improved greatly and are now nipping at our heels.

American eighth-graders slightly improved their science scores from 1995 to 2003, when they placed ninth among 44 participating countries. But, again, some Asian countries—Singapore, Korea, and Japan—beat our kids decisively.

Those three Asian nations have recently touted biotechnology spending and expertise. Singapore, for instance, has spent $4 billion on biotechnology facilities, including a glossy new research complex called *Biopolis*. It plans to spend $10 billion more on biotech infrastructure. Singapore has already recruited top U.S. researchers to the Asian city-state.

Why do certain countries perform so well on international student comparisons? A high-scoring Asian country typically has a national curriculum that focuses on a small number of science topics. An Asian country's teacher might teach a handful of topics instead of dozens of topics required for an American teacher. These countries also offer teachers the training and resources to do their jobs.

280,000 new math and science teachers in American classrooms will be needed. College education programs aren't attracting nearly enough students to fill these future posts. One-third of South Carolina teachers—and one-third of U.S. teachers—leave the profession after five years. Annual turnover rates for teachers can be as high as 40 to 50 percent in some rural school districts.

Particularly in schools serving low-income homes and communities, administrators can't find enough teachers certified to teach math or science. So they often hire people without certification in those subjects. No state in the nation, in fact, is on pace to get a highly qualified teacher in every class as required by the 2001 landmark federal law No Child Left Behind.

Almost half of U.S. high-school students don't enroll or don't have chances to enroll in what are labeled "college prep" curricula. Only 31 percent of high-school graduates complete a basic college prep curriculum, which includes math and science. Only 14 percent of students take advanced courses in math and science, in many cases because many schools don't offer such courses.

One million college students annually take remedial courses covering math topics that already should have been learned in high school, according to the Mathematical Association of America. Many of these students will end up dropping out of college. In the U.S. system, it's relatively easy to get into higher education but much more difficult to graduate, especially in science- and math-related majors.

A generation ago, a semi-skilled worker could make a decent living on an assembly line doing the same thing hour after hour. But those jobs are disappearing and probably won't come back. Instead, cutting-edge technology has transformed manufacturing and most other economic sectors. In the future, employees will increasingly need some degree of math and science skills to handle jobs in technologically sophisticated workplaces.

Four out of five high-school sophomores say they expect to go on to college, but only a fraction of high-school seniors are enrolling in courses that will help them succeed there. Education scholars point to reasons for this disconnection between hope and reality. Children aren't receiving the early, continuous, and rigorous guidance they need.

A HUGE TRANSITION PERIOD

When do many American children start falling behind in science?

In the United States, "students are permanently knocked off the pathway" to a science-related field "early in high school or even before," observes Kevin Carey, research and policy manager with Education Sector, an education think tank in Washington, D.C. "This is particularly true for low-income and minority students."

A high-school student just beginning to get serious about science is late coming into the game. Carmelina Livingston, lead teacher at the St. Andrews School for Math and Science in Charleston, says, "You need to start them in the beginning—at the elementary-school level."

Yet few elementary-school teachers are adequately prepared to teach science. "Most don't understand the nature of science," says Van Sickle. "They don't do science. That's a long-term problem in this country."

In the United States, effective science instruction usually begins in middle school, where teachers are struggling through a "huge transition period" from rote learning to discovery learning, says Leslie Sautter.

Spigner, the West Ashley High School teacher, sees novice science instructors in particular "just trying to stay above water. It's difficult to get them to do many inquiry labs because they are still learning the basics of classroom management. Many lack the content knowledge and the tons

READY FOR INVESTIGATION. ***"Hands-on learning is one of the best things that's come along," says Phillip Jones, manager of the Charleston County School District Science Materials Resource Center, taking stock of science-education kits to be distributed to teachers.*** PHOTO/WADE SPEES

of experiment materials that inquiry takes. First-year teachers especially have it tough."

FRANTIC INSTRUCTION

Science instruction in American middle schools is typically fast-paced, even frantic, jumping from topic to topic. Science textbooks in the United States have traditionally covered far more topics than those of other advanced countries. In the late 1990s, teachers in Japan covered an average of 13 science topics in eighth grade, while American teachers covered an average of 24. American teachers have had to race to keep up with over-packed curricula.

Some U.S. school districts, for instance, still expect teachers in elementary and middle schools to meet as many as 100 separate objectives in math.

The S.C. Department of Education provides classroom science kits and training for teachers. PHOTO/WADE SPEES

For two decades, the U.S. science curriculum has been called "a mile wide and an inch deep." Reformers have made efforts through various science standards to deepen the curriculum, but U.S. teachers still have a great number of topics to cover. As a result, many teachers continue to lack enough time to guide students through complex science projects.

"There are such a large number of details that teachers have to cover in the science curriculum," says S.C. Sea Grant researcher Rob Young, a Coastal Carolina University marine scientist. "It's difficult for teachers to cover all of the breadth of details in the curriculum and also help students reach any depth of scientific thinking."

Still, South Carolina has made some progress in pruning its science topics. The newly adopted 2005 state

South Carolina science standards, scores improving

In 2005, South Carolina's statewide science curriculum standards were graded as among the best in the country by the Ohio-based Thomas B. Fordham Institute, which supports education reform.

The institute gave South Carolina's state science standards an A, one of only four states to receive the highest grade. Twenty-nine states and D.C. got a C grade or lower.

The report criticized many states for aggressively embracing discovery learning so that they squeeze out "the underlying core of scientific knowledge. Of course, students should engage in the laboratory or field, but they also must learn and memorize some things—facts, words and definitions, and problem-solving techniques, for instance."

Many state science standards, according to the report, over-emphasize discovery learning "to an absurd level, declaring that all knowledge should be 'discovered' by the student rather than passed along by the teacher."

By contrast, South Carolina's science standards stand out as sensible and understandable, notes the Fordham report, which analyzed the state's 2000 science standards. Revised 2005 standards will be used in the 2006-2007 school year.

Having high-quality standards, says Sinclair, is an important reason why South Carolina students overall achieved impressive gains in science from 2000 to 2005 in the National Assessment of Education Progress (NAEP), a comprehensive examination administered by the Department of Education in all 50 states, the District of Columbia, and U.S. military bases around the world.

South Carolina fourth-graders recorded the largest score increase over that period and its eighth-graders recorded the third-largest increase. Still, South Carolina students remained below the national average in science.

science standards "reduce considerably the number of science topics at every grade level," says Sinclair of the state education department. "We now have fewer science topics, which allows for greater explanation and understanding. Children will remember what they've learned."

Many teachers, moreover, have difficulty teaching what they've never had a chance to do themselves: follow a science project from beginning to end.

A 2005 National Academy of Sciences report notes that teachers especially need more chances to receive training in scientific processes. "Once on the job, science teachers have few opportunities to improve their laboratory teaching. Professional development opportunities for science teachers are limited in quality, availability, and scope and place little emphasis on laboratory instruction."

Young directs the Rising Tide Project, which brings researchers, teachers, and undergraduates together to collaborate on science investigations in local marine environments.

Says Young, "Often, teachers have a pretty good science background but might never have done an actual science project from hypothesis to conclusion. Or they're teaching a subject that they didn't focus on during their college education. They have a lot of teaching experience, and they know a lot of scientific facts, but they might never have participated in a full-scale research project.

"In the Rising Tide Project," Young adds, "we'll have a science teacher work with a university faculty member and an undergraduate on an individual research question throughout the summer. Teachers learn how to attack a scientific question, to use all of the critical thinking involved in experimental design and data analysis and interpretation, moving from hypothesis to a conclusion." Then teachers can bring their knowledge of scientific processes back to classrooms and labs.

COMPARING TEACHING PRACTICES

An international study shows that U.S. eighth-grade science teachers often fumble discovery learning because they provide scant or no guidance to students. American teachers are commonly allowing children to wander through class experiments without significant discussion of science principles.

Eighth-grade science-teaching practices in the United States are distinctive compared to those of four other nations—Australia, the Czech Republic, Japan, and the Netherlands—where students have scored about the same or higher on science-achievement tests, according to a Trends in International Mathematics and Science Study (TIMSS) "video study" report released in April 2006.

TIMSS researchers studied what happens in classrooms and why instruction can go off the rails. Researchers randomly chose eighth-grade science classrooms in five countries, including the United States. Classrooms were videotaped in 1999 and teaching practices analyzed. Researchers described techniques in each country and identified similarities and differences.

"In the U.S., students learn to do hands-on activities," says Patrick Gonzales, an education-policy analyst and the TIMSS U.S. coordinator, "but not why those activities are important. Students are kept very busy, but there is little indication that teachers are providing explicit guidance about how activities connect to science—to the process of science and the big ideas of science. Teachers are not engaging students in science thinking."

More than one-fourth of U.S. eighth-grade science lessons are devoid of science, filled with "activity for activity's sake, with no links to science content," says Gonzales.

In a biology class, for instance, American students might dissect a frog, but teachers often don't link the experiment to science concepts such as how amphibians are different from or similar to mammals or reptiles, or any other important science principles, says Gonzales. Frogs are dissected but many U.S. teachers offer no explanation of why the lab is done.

An experiment performed in an American classroom commonly stands alone, without context or linkages to the primary ideas of science. "The U.S. just

ELEMENTAL.
A second-grader confers with Carmelina Livingston, lead teacher at St. Andrews School of Math and Science in Charleston. These youngsters are making predictions. How fast will a Popsicle melt and why? Experienced teachers guide hands-on science activities but also explain how an experiment relates to science principles.
PHOTO/ WADE SPEES

isn't quite pulling it all together," says Gonzales.

By contrast, in the other four countries, an eighth-grade teacher will explain at the beginning of class exactly which science ideas are to be explored and how they connect to an experiment. Then the teacher guides hands-on activities but also continues explaining how the experiment relates to science principles. At the end of class, the teacher reiterates the science concepts and how classroom activities illuminated those ideas.

John Stover, who teaches industrial technology, a science elective, at Batesburg Leesville Middle School in rural Lexington County, says, "I do the lab first and then the theory—about 60 percent hands-on to 40 percent classroom science and math. If you teach the theory first, the students don't have enough real-world experience to understand it."

TIMSS researchers videotaped classrooms seven years ago, and teaching methods could have improved since then, experts say. The movement toward discovery learning is still relatively new, and teachers continue learning how to do it.

A variety of education and science agencies have pitched in to help teachers understand discovery learning. Agencies have offered a wealth of inquiry activities and training programs for teachers. These programs have improved the quality of classroom experiments, experts say.

The S.C. Department of Education, for example, provides classroom science kits and professional-development for teachers. The kit-based programs were developed with funding from the National Science Foundation (NSF) and the Lawrence Hall of Science at the University of California at Berkeley.

Starting in 2001, Charleston and Berkeley county school districts received a five-year, $5 million NSF grant, which supplements the state program.

"These classroom activities are definitely tied to science concepts," says Carol Tempel, an administrator with Charleston County School District and principal investigator for Project Inquiry, an NSF-funded teacher enhancement grant. "The activities are meant to help students experience and understand the science content more deeply. We're working with high-quality materials and supplies circulated to 95 percent of middle-school teachers in the district through a science-resource center."

ROB YOUNG

It's difficult for teachers to cover all of the breadth of details in the curriculum and also help students reach any depth of scientific thinking.

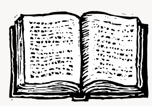
About half of the science teachers in the two school districts have completed the equivalent of three graduate courses, which offer training in applying hands-on activities in classrooms.

TEACHING TEACHERS

American teachers get little respect from an ungrateful public. No wonder that so many young teachers leave for other careers.

"The real problem is that teaching pays low salaries, has low status, and offers poor working conditions," writes Arthur Levine, president of the

Reading And Web sites



America's Lab Report: Investigations in High School Science. Washington, D.C.: National Academies of Sciences, 2005.

Business-Higher Education Forum
www.bhef.com

Education Sector
www.educationsector.org

Trends in International Mathematics and Science Study
nces.ed.gov/timss

Highlights from the TIMSS 1999 Video Study of Eighth-Grade Science Teaching. National Center for Education Statistics. April 2006.

Highlights from the Trends in International Mathematics and Science Study (TIMMS) 2003. National Center for Education Statistics. December 2004.

National Marine Educators Association
www.marine-ed.org

National Science Teachers Association
www.nsta.org

NOAA Office of Ocean Exploration
explore.noaa.gov

Ocean Literacy Network
www.coexploration.org/oceanliteracy

Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future. Washington, D.C.: National Academies of Science, 2005.

Sea Grant Educators Network
www.seagranted.net

Sea Perch
web.mit.edu/seagrant/edu/seaperch

Thomas B. Fordham Institute
www.edexcellence.net/institute/global/index.cfm

The Centers for Ocean Sciences Education Excellence (COSEE)
www.cosee.net

The Center for Ocean Sciences Education Excellence–SouthEast (COSEE-SE)
www.scseagrant.org/se-cosee

Southeast Phytoplankton Monitoring Network
www.chbr.noaa.gov/pmn

COASTeam Program, Project Oceanica
oceanica.cofc.edu/coasteam

S.C. Marine Educators Association
oceanica.cofc.edu/scmea/index.html

Teachers College of Columbia University. "Education is not a competitive choice for the nation's most able young people, for whom law, medicine, and business—fields that pay median salaries two-to-four times as large as those in education—are far more appealing."

Strong administrators, effective school discipline, and attentive parents are essential ingredients to improving public education. Lacking those elements, it's difficult for students to succeed.

What else is needed? Four things, analysts say. Raise teacher salaries. Improve preparation for candidates studying to be teachers. Offer better professional-development opportunities for teachers. And create more focused, relevant curricula.

Released in 2006, a National Academy of Sciences report, *Rising Above the Gathering Storm*, argues that the nation's first priority in science education should be to increase the talent pool of teachers. The committee comprises active and retired business executives, university presidents, and Nobel Prize-winning scientists.

The report calls for increased scholarships, up to $20,000 a year, for annually recruiting 10,000 of the "brightest students" into the teaching profession, as well as providing up to $1 million in grants to universities that promote science and engineering degrees in conjunction with teaching certification. The report also calls for improving the skills of 250,000 teachers through training and education programs.

President Bush, in his 2006 State of the Union address, called for a much narrower priority: retraining 70,000 teachers over four years to prepare them to teach science and math.

"You have to do both," says Keener-Chavis. "You need more professional development for teachers and more teachers in the pipeline for the future."

For more than a decade, the S.C. Sea Grant Consortium has supported the College of Charleston's COASTeam Program, which trains teachers in discovery-learning techniques. This program offers graduate-level courses in marine-science education, providing science teachers with curriculum materials they can use in classrooms. The materials include hands-on activities and resources focused on the South Carolina marine environment.

Leslie Sautter developed and directed COASTeam from 1994 until it was adopted in 2006 by the Center for Ocean Sciences Education Excellence–SouthEast (COSEE–SE), which is charged with promoting educational programs of excellence within the Southeast region. COSEE-SE, funded by the National Science Foundation, NOAA Coastal Services Center, and supported by the S.C. Sea Grant Consortium, will extend the COASTeam Program into selected schools in South Carolina and later into North Carolina and Georgia.

"COASTeam addresses science topics," says Sautter, "that can be demonstrated through hands-on activities and supplemented by content background. Teachers leave the courses with confidence that they'll know what to do in the classroom because they've learned the content using the same methods they will use to teach to their students."

Not everyone should go to college, skeptics say. The reality, however, is that most jobs today demand some kind of post-high-school education, including two-year community college or technical school.

The goal should not be pushing more young people into higher education. Instead, the goal should be allowing more youth—not just the gifted—to have an opportunity to learn difficult subjects in every year of school. Only then will we have more young people leaving school with science, math, and communications skills that allow them to succeed.

Great ideas for ocean-science education

Few scientists understand how students learn in K-12 classrooms. In turn, few teachers have access to up-to-date techniques of teaching marine and aquatic science. Scientists and teachers need more chances to work together on ways to bring science into K-12 classes.

That's why the Center for Ocean Sciences Education Excellence–SouthEast (COSEE–SE) was created. The center provides a clearinghouse of professional-development opportunities for K-12 teachers, while advancing ocean-sciences education in North Carolina, South Carolina, and Georgia.

In June 2006, for instance, COSEE-SE and the S.C. Sea Grant Consortium organized the Sea Perch Educators Workshop for teachers at the S.C. Department of Natural Resources Marine Resources Center Outdoor Classroom at Fort Johnson on James Island.

The teachers learned how to make a "Sea Perch," an underwater remotely operated vehicle (ROV). The Sea Perch, created by the Massachusetts Institute of Technology Sea Grant Program, introduces the technology for aquatic exploration in middle and high schools.

The ROV has exciting applications for students who want to explore aquatic environments. The Sea Perch can carry cameras and other sensing equipment underwater. Powered by a 24-volt battery, the vehicle is capable of diving 40 feet and collecting data from a pond bottom. This device also allows for hands-on training in inquiry learning for electricity, buoyancy, and engineering, among other science content.

"We are trying to push the edge a little bit in applying education research and theory, improving sharing of ideas among educators and science researchers," says Lundie Spence, director of COSEE-SE.

The National Science Foundation, with support from the NOAA Coastal Services Center, has provided funding for COSEE-SE.

As part of the COSEE network of 10 centers across the United States, COSEE–SE creates opportunities for scientists, teachers, and other educators to brainstorm about how to help students and the public understand the role of the oceans in their lives.

OCEAN*Literacy*

Hurricane destruction and Gulf Coast reconstruction, ice melting in the Arctic Ocean and Antarctica, tsunamis, port security, and rising sea levels. The news is brimming with stories about oceans and coasts. It's becoming increasingly difficult to understand national and world affairs without knowledge of the ocean.

The ocean regulates the planet's climate and, at the poles, provides early warnings of climate change. The ocean drives much of the intense weather—from hurricanes to droughts to inland flooding—around the globe.

Yet American students have few chances in class to learn about the ocean. Ocean sciences aren't part of the formal K-12 curricula in most areas of the country, and ocean studies are missing from most educational standards and assessments.

"Teachers are almost exclusively using terrestrial examples in classrooms," says Elizabeth Rogers, marine educator for the S.C. Sea Grant Consortium. "Teachers, for example, typically explain that tropical forests provide a portion of the Earth's oxygen. But students really need to learn that plants in the ocean provide about half of our oxygen. That offers a whole new spin on why the ocean is important."

It's been a half-century since the Soviet Union launched the Sputnik satellite, which shocked U.S. policymakers into investing more in science education. Today, the nation is facing a new crisis—and this one's in the ocean.

According to the U.S. Commission on Ocean Policy 2004 report, seaports and coastal oil-and-gas facilities are vulnerable to natural disasters and terrorism, population growth is exploding

KNOWLEDGE TRANSFER. *Clay McCoy (left), coastal processes specialist with the S.C. Sea Grant Extension Program, watches over sixth-graders from St. Andrew Catholic School in Myrtle Beach during a science-education workshop on Waites Island. Karen Fuss, an environmental educator with the Burroughs and Chapin Center for Marine and Wetland Studies at Coastal Carolina University, leads workshops for K-12 students.* PHOTO, OPPOSITE/CHERYL YOUNG

REAL-WORLD SCIENCE. *Meghan Ward (left), a marine-science teacher at James Island Charter High School, and Fred Phillips, a biology teacher at Wando High School, make a "Sea Perch," an underwater remotely operated vehicle (ROV, see page 11). The Sea Perch, created by the Massachusetts Institute of Technology Sea Grant Program, has exciting applications for science students. It can carry cameras and other sensing equipment underwater.* PHOTOS/LEFT:WADE SPEES, RIGHT: SUSAN FERRIS HILL

along shorelines without adequate planning, and many communities are poorly prepared for hurricanes and other storms. A Pew Commission report made similar observations.

Americans know little about the ocean's importance in our lives. For instance, most items we purchase are produced overseas and brought here by ocean-going ships. In a single day, an American might wear clothes made in India or China, eat Mexican-grown tomatoes and Indonesian shrimp washed down by Costa Rican coffee or German beer, fill the tank of a Japanese car with gas from Kuwait, and watch a television manufactured in South Korea. We also sell vast amounts of goods abroad, nearly all of it hauled by ocean-going ships. One of six U.S. jobs is tied to international trade.

Yet nearly 30 percent of Americans age 18-24 can't even find the Pacific Ocean on a map, according to the National Geographic-Roper 2002 Global Geographic Literacy Survey.

Even before Hurricane Katrina, experts were calling for more investment in ocean studies and science education. "Ocean-related education… has the potential to stem the tide of science illiteracy threatening to undermine the nation's health, safety, and security," says the commission's report.

In response, representatives from the National Geographic Society, the National Marine Educators Association, NOAA, the Centers for Ocean Sciences Education Excellence (COSEE) Network, and other programs worked together to create a consensus on ocean literacy. The group defined ocean literacy as an "understanding of the ocean's influence on you and your influence on the ocean."

Now, educators are working to incorporate the principles of ocean literacy into national and state standards, assessment, and curricula.

"Ocean literacy is being raised at the national level for the first time," says Paula Keener-Chavis, director of Education Programs for the NOAA Office of Ocean Exploration. "The Ocean Commission and the Pew Commission reports emphasized the need to teach about the Earth as a system. We live on an ocean planet, and the ocean is in trouble, and that's an important reason to teach about it. We need to start working toward an ocean-literate public in a coordinated way, and we can't let the momentum slow down."

7 Essential Principles of OCEAN LITERACY

1. The Earth has one big ocean with many features.
2. The ocean and life in the ocean shape the features of the Earth.
3. The ocean is a major influence on weather and climate.
4. The ocean makes the Earth habitable.
5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.
7. The ocean is largely unexplored.

EBBS & FLOWS

6th Annual New Partners for Smart Growth Conference: Building Safe, Healthy, and Livable Communities

Los Angeles, California
February 8-10, 2007

The New Partners for Smart Growth Conference is now considered the premier smart growth conference. Its strength comes from the variety of participants and speakers who cross disciplines to share experiences and insights, plus valuable tools and strategies to encourage smart-growth implementation.

The 2007 program will feature the latest research, implementation tools and strategies, case studies, interactive learning experiences, and new partnerships and projects.

For more information, visit www.newpartners.org or contact Michele Kelso Warren at (916) 448-1198 or mkwarren@lgc.

CNREP 2007: Challenges of Natural Resource Economics and Policy

New Orleans, Louisiana
May 20-23, 2007

This conference focus will include opportunities and challenges of socio-economic research in developing coastal zone management policy. Potential session topics include, but are not limited to, market and nonmarket valuation of coastal resources, environmental benefit-cost analyses, economic linkage/impact assessment, input-output modeling, and comparative assessments of resource management and restoration policy.

For more information, visit www.CNREP.lsu.edu or contact Dr. Richard F. Kazmierczak, Jr. at rkazmierczak@agcenter.lsu.edu.

National Marine Educators Association Conference 2007

Portland, Maine
July 23-27, 2007

You'll find new ideas and become part of a national network of valuable resources by attending the National Marine Educators Association Conference.

NMEA 2007 is about joining together with marine educators from across the country to to celebrate the "Downeast" part of the world. For information, contact Downeast2007@gommea.org.

ATTENTION SCHOOL TEACHERS! The S.C. Sea Grant Consortium has designed supplemental classroom resources for this and past issues of *Coastal Heritage* magazine. *Coastal Heritage Curriculum Connection*, written for both middle- and high-school students, is aligned with the South Carolina state standards for the appropriate grade levels. Includes standards-based inquiry questions to lead students through explorations of the topic discussed. *Curriculum Connection* is available on-line at www.scseagrant.org/education.htm.

Subscriptions are free upon request by contacting: Annette.Dunmeyer@scseagrant.org

Sea Grant
S.C. Sea Grant Consortium
287 Meeting Street
Charleston, S.C. 29401

NON-PROFIT ORG
U.S. Postage Paid
Charleston, SC
PERMIT #248

Coastal Heritage is printed on recycled paper.
Web site: www.scseagrant.org