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Water Science in the Public School Classroom

Exciting and Educating Students About the Environment

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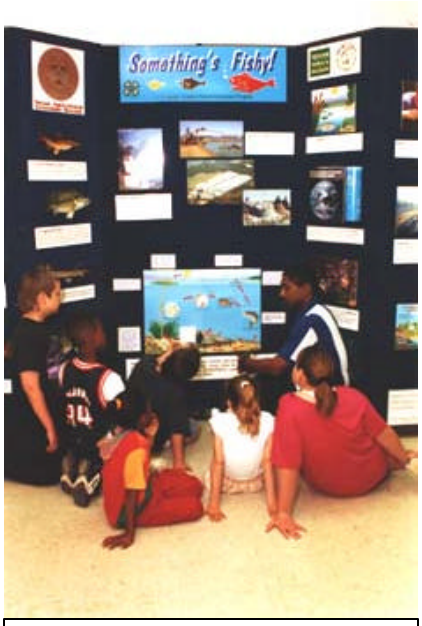
Water resources education in the public schools is essential. The children of today will become the leaders of tomorrow. Can we supply them with information and excitement about the environment so that they will want to pursue scientific careers? Can we provide students with a broad perspective so they understand complex issues like groundwater depletion, water pollution, global change, and water laws? Ultimately, our children must develop the skills in basic science and mathematics they need to become engineers, environmentalists, and water resources managers.



Smith County Extension agent Fred Burrell demonstrates "Something's Fishy" to area schoolchildren.

Throughout Texas, much is being done to promote water resources and environmental education. This issue discusses water and environmental K-12 education in Texas, provides information about TWRI water education efforts, and illustrates creative education programs being conducted in Texas.

Introduction

Nationally, many groups are working to define what constitutes environmental education and to set goals of what type of teaching and learning should occur. The U.S. Environmental Protection (EPA) takes a lead role in fostering environmental educational efforts. An article by EPA Administrator Carol Browner in the spring 1995 issue of *EPA*

Journal asserts that environmental education at the K-12 level is essential if we are to produce future citizens and leaders who are knowledgeable about and care for natural resources. Another article in that issue describes results of a national survey of grade 4-12 students conducted by the National Environmental Education and Training Foundation in 1994. Results show that high school environmental education may be inadequate, that kids learn best through hands-on techniques, and that youth from disadvantaged areas are often more concerned about immediate environmental problems.

The North American Association for Environmental Education recently teamed up with EPA and others for a national environmental education summit. Ideas from that meeting are now being compiled into goals and priorities for environmental education to be published next year. Goals are expected to focus on ensuring that classroom educators have access to high quality, impartial information; that educators have strong backgrounds in environmental sciences; that environmental education be incorporated into overall curriculum development; and that research programs be established to support environmental education and improve its effectiveness.

The Pineywoods Conservation Center at Stephen F. Austin State University (SFASU) is organizing workshops to help write voluntary environmental education guidelines for Texas.

The Texas State Board of Education sets the standards and guidelines for all aspects of classroom curriculum. The Texas Education Agency (TEA) implements these policies and coordinates education efforts throughout the state. Senate Bill 1340 ("the Omnibus Recycling Bill") was passed in 1991 and adopted as an amendment to the Texas Education Code. It mandated the Texas Commissioner of Education to incorporate environmental education into existing curriculum.

The Texas Environmental Education Advisory Committee (TEEAC) was created in 1991 to advise the Commissioner of Education on how to incorporate environmental education into all subjects in all grade levels. TEEAC oversees a network of 100 teacher training sites and recognizes teachers who participate in training courses. With the total rewrite of the Texas Education Code in 1995, the Commissioner's environmental mandate was eliminated, although TEEAC continues to exist and works with the Commissioner and TEA staff.

As a result of recent philosophical changes in education policy, a new set of Texas Essential Knowledge and Skills (TEKS) is being written that places a lesser priority on what science teachers must teach and more emphasis on what students must master. TEKS, which will become an official part of TEA rules, are now being modified and are expected to be adopted this summer. They will replace the Essential Elements for Education that previously defined curriculum standards. TEEAC members and many others are reviewing drafts of TEKS in many subject areas, including science, social studies, and related areas.

EPA Programs

Since 1990, EPA has supported many environmental education programs. The EPA Environmental Education Grants Program provides funds from $5,000 to more than $25,000 to expand communications and partnerships, to educate youth and adults to protect the environment, to promote environmental careers, and to bridge environmental boundaries.

From 1992-95, the EPA Region 6 Office in Dallas awarded more than 50 grants to promote environmental education in Texas. Many projects are especially innovative (for example, producing a video to teach students about how their daily decisions impact the environment, developing a magic show that Texas Natural Resource Conservation Commission (TNRCC) staff use to teach environmental education to public schoolchildren, and providing outdoor experiences for inner city youth). Other projects used EPA funds to increase hands-on teacher training, to implement and continue water quality monitoring efforts, and to develop and construct environmental centers at individual schools. Brief summaries of many projects can be obtained by contacting the EPA Dallas office at (214) 665-2200 or by visiting the National Consortium for Environmental Education and Training on the WWW. Other EPA programs foster teacher training and internships that allow teachers to work with scientists.

Efforts by Federal and State Agencies

The U.S. Geological Survey (USGS) has developed educational materials for teachers, including posters that depict groundwater, wastewater treatment, water use, navigation, non-point pollution, and wetlands. They produced lesson plans about groundwater issues that junior high school teachers can use. USGS personnel visit schools and make presentations, as resources allow. The USGS has created two WWW sites with environmental education resources.

The National Park Service has developed a WWW site called "Tools for Teaching" that contains information on archeology, historic places, museums and maritime resources, study guides, glossaries, and lesson plans.

State agencies are developing and implementing water resources and environmental education programs. The Texas Education Awareness Network (TEAN) is a partnership of state agencies, businesses, and non-profit groups that work together to provide teachers and students with curriculum materials. TEAN produces the "Eye on Earth" television show which is broadcast live monthly during the school year on TEA's T-STAR satellite network. TEA has provided funds so each school district can purchase the equipment to receive the program and it can also be viewed by anyone with a satellite receiver. Recent topics included monitoring and caring for water supplies, the Texas coastline, and biodiversity.

TNRCC supports environmental education by offering training for public school teachers through the Teaching Environmental Science (TES) program, training K-12 teachers to

initiate water quality monitoring programs, and publishing educational resources for teachers and students, including newsletters, manuals and brochures.

"Teaching environmental education supports students doing critical thinking about the environment," said Barbara Henry of TNRCC, who coordinates the TES program. "Environmental education goes beyond science classes and includes literature, history, mathematics, and social studies," she says. "The real value of environmental education is that it may be our best way to change behavior in young people. It's harder to change the thinking and actions of adults. Because it teaches the principles of stewardship and identifies results of our behavior, it helps children develop a moral center." The course combines hands-on classroom teaching with laboratory experiences and presentations by outside experts. Participants take many trips to sites in the community that influence the environment. Teachers are tested about environmental knowledge and skills when they enter and exit the program. Jim Westgate of the Lamar University Geology Department participated in the TES course in Beaumont this Summer. "We had 13 teachers in the course and they seemed to thoroughly enjoy it and gain a lot from it. I think it's very successful."

Eddie Siedensticker of the U.S.D.A./ Natural Resources Conservation Service shows students how to take soil samples.

In 1997, TES courses are planned for Texas A&M University-Corpus Christi (TAMUCC), Lamar University, Texas Southern University, the University of Houston-Clear Lake (UHCL), SFASU, the University of Texas at El Paso, Texas Tech University, the University of North Texas, and Southwest Texas State University (SWTSU).

TNRCC coordinates the "Texas Watch" volunteer water quality monitoring program. The program provides hands-on training and support materials to local groups to monitor and collect data from lakes, rivers, and aquifers. Roughly 40% of Texas Watch monitoring groups are K-12 teachers and their students. By teaching students to measure what is happening in the environment around them, Texas Watch helps teachers present the concepts of biology, chemistry and ecology. Teachers who receive Texas Watch training have many options for involving students in environmental monitoring. Students can monitor waters under a teacher's supervision with activities based on educational objectives of the class, and teachers can train junior high and high school students to become certified monitors. The Plano Independent School District (ISD) is incorporating Texas Watch its K-3 curriculum, fifth graders in the Alief ISD are testing water quality in Houston bayous and Canyon High School gathers water quality data from the Comal and Guadalupe rivers.

The Texas Parks and Wildlife Department (TPWD) has developed educational resources, which can be located on their "Teaching Nature and Having Fun" WWW site. TPWD efforts include Project WILD and Aquatic Project WILD, and curriculum materials covering Texas ecoregions and endangered species. Activities in Aquatic Project WILD include identifying aquatic habitats that many species need to survive, determining the ecological consequences of building dams, and investigating why some fish species have declined.

The Texas General Land Office (GLO) hosts beach cleanups and other activities students can participate in. They sponsored a contest in which 4,500 K-6 grade students submitted posters depicting what they like best about the Texas coast. GLO published a poster with the top 100 entries in printed form and on the Internet. GLO maintains an electronic bulletin board system (BBS), "E-Source," that can be used to obtain information about educational resources relating to recycling, marine issues, and ecology.

The Texas Department of Transportation (TxDOT) developed a program titled "Giving Nature a Hand." It describes ecosystems that exist near highway and tells how TxDOT utilizes native grasses, xeriscaping, and prairie restoration to minimize pesticide use.

The Texas State Soil and Water Conservation Board is developing a "Water Quality Education Module" to help youth understand the relationship between water supplies and water quality. The Board will soon implement "Project Food, Land, and People" which will incorporate information about natural resources conservation into K-12 education.

Project WET

Project WET (Water Education for Teachers) is a popular way to introduce K-12 teachers to water resources curriculum material. The goal is to facilitate and promote the awareness, appreciation, knowledge, and stewardship of water resources through classroom teaching. Teachers receive hands-on training and instruction in activities that emphasize the chemistry and physics of water, life and earth sciences, natural resources, and water resources management. Teachers receive a manual with more than 90 lesson plans. Many modules are multidisciplinary and include graphing and mapping, gathering and recording data, and role playing. In one lesson, students investigate if a cemetery is contaminating local aquifers, while others show students how to create a musical "rain stick" and how to monitor their water use.

In Texas, Project WET is coordinated by the Caddo Lake Institute in Marshall (the phone number is (903) 938-3545). Sites that offer Project WET training in Texas include the Texas A&M University (TAMU) Wildlife and Fisheries Sciences Department (students are trained in Project WET, Project WILD, Project Aquatic WILD, and Project Learning Tree), and the UHCL Environmental Institute of Houston. TNRCC published a manual that teachers can use to teach Project WET in Texas.

TWRI Efforts

Recently, TWRI has contributed to water resources public school education. Efforts include assessing the ability of K-12 teachers to use the WWW and funding education projects.

Ric Jensen of TWRI recently completed a study funded by the EPA Environmental Education Grant program. In 1995, Jensen worked with Glenn Shinn of the TAMU Agricultural Education Department to develop a survey to assess the capability and interest of Texas K-12 teachers to use the WWW for classroom instruction. Jensen identified Texas schools and districts with WWW sites using TEA data. He contacted each school to schedule live demonstrations of the TWRI WWW site, "Texas WaterNet," at their site. Jensen visited 15 schools throughout the spring and summer of 1996 and provided 30-minute presentations about the use of the WWW for classroom science teaching. Following each visit, Jensen distributed and collected the survey. Later, survey results were analyzed. Jensen's study shows that only 45% of the 100 Texas teachers surveyed used the Internet, and that the number of individuals using hard-wired connections was equal to those using modems. Most of those surveyed were general science teachers (47%), followed by computing and mathematics, and most taught grades 6-8 (45%). Participants said that they want to use the WWW to help students do research and to supplement existing lessons, but they were less enthusiastic about using the WWW for in-class presentations and to develop new lessons. Teachers responded overwhelmingly that they wanted WWW sites describing the work of Texas universities in water research, and sites with Texas water and environmental information. Teachers said they were likely to use the sections of the TWRI WWW site containing on-line newsletters, links to other sites, and search engines, but were less apt to use TWRI's technical reports and university water experts directory. "This implies that the material teachers will use must be geared to student needs and can't be too technical," Jensen says. "Teachers and students are looking for WWW sites that educate and entertain."

Kids make water flow in different directions with the "Wonderful Water" exhibit.

TWRI provided funding for an exhibit that is part of the Children's Museum of the Brazos Valley. "Wonderful Water" allows children to learn about water by adding dams to a stream table, turning valves and placing items in a wall of water. "The exhibit is popular with young children," says Dale Whittaker of the TAMU Agricultural Engineering Department and a founder of the museum. "These exhibits are built low to the ground and it's fun for them because it's very hands-on. Kids like to touch the water

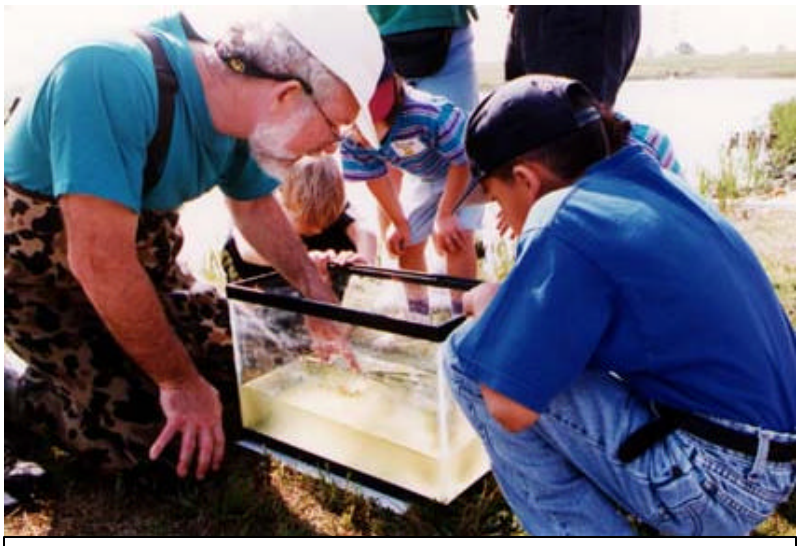
and hear it move," Whittaker said. At Bryan's recent "FestiFall," hundreds of children and adults enjoyed the exhibit. "It's amazing how children react to a hands-on type learning experience. There are no grown-ups telling them what to do and not do. The children call the shots." "Wonderful Water" will shown in the region this year. TWRI hopes it will be displayed at the Museum's permanent site.

TWRI and TPWD funded the "Something's Fishy" educational program developed by Billy Higginbotham of the Texas Agricultural Extension Service in Overton. The program is based on TAAS objectives and teaches fourth graders about aquatic environments and the importance of water quality and water conservation. The program uses videotapes, an interactive computer program, water test kits, and a display that contains replicas of common Texas fish species. The program teaches principles of the aquatic food web, sport fishing, aquaculture, and water conservation. "This program is meant be kid friendly," Higginbotham says, "and is structured around teaching objectives so the children are learning while they're having fun." Higginbotham's studies suggest this program significantly increases student knowledge of environmental issues. He also developed "Wildlife Success Stories and Endangered Species" curriclum package and CD-ROM.

Work at Texas Universities

Bob James directs the Texas Alliance for Science, Technology, and Mathematics Education at TAMU. The Alliance sponsors many programs for K-12 educators including the annual YOUth symposium where teachers and students come to TAMU to hear from scientists. Many mentoring programs developed by the Alliance create opportunities for science teachers to work with universities, government agencies and the private sector to learn hands-on skills they can take back to the classroom. Lockwood Cox, an environmental science teacher at Little Cypress-Mauriceville High School in Orange, worked as a Summer intern at the TAMU Agricultural Research and Extension Center in Beaumont in an Alliance program and learned about rice research. "I'm thankful for the program," he says. "It exposed me to many aspects of science and research that I have used to improve my curriculum and got me started in volunteer water monitoring." The Alliance is developing an "On-Line School" on the WWW that will house training and reference materials for teachers. They are developing a project that will link classrooms in Central Texas with inexpensive video cameras that can be mounted to computers. "This will allow teachers and students to ask experts questions about water issues," James says.

Carol Stuessy and Jim Zuhn of the TAMU Education Curriculum and Instruction Department are developing a WWW site with resources teachers can use to understand the new requirements introduced by the TEKS program, and to help students master these concepts. The project is a cooperative effort with the University of Texas at Austin (UT) Dana Center for Mathematics and Science Education. The WWW site will contain a copy of the TEKS criteria, strategies for instruction and assessment, clarifying activities that can be used to teach key skills, and links to teaching resources.



Jim Lester of the Environmental Institute of Houston at UHCL shows students how to work with aquariums.

The TAMU Agricultural Education Department is involved in projects focusing on environmental and natural resources education. Researchers in the department work with 130 agricultural education teachers and 4-H and Future Farmers of America programs. Soon, they hope to play a major role in developing and transmitting agricultural education programming for the TAMU Distance Education Center. "Environmental education is becoming a big part of agricultural education because the suburbs are spreading out to the rural areas," says Glenn Shinn of the Department. "Children who live in rural settings want to learn more about nature and ecosystems."

Students and teachers wishing to explore watersheds might want to take part in "The Great River Runs," sponsored by the Marine Advisory Service, the Texas Sea Grant Program, and river authorities. The program provides trips down the Neches, Guadalupe, Blanco, and Colorado rivers. Students and teachers begin near the headwaters of each river and finish the trip where the rivers enter bays. They navigate as much of the river as possible, observe the effects of wastewater treatment, water pollution, and power generation, and learn about recreation, fishing, and fisheries. Roughly 25 teachers and 45 students have participated.

TAMUCC staff are working with the U.S. Fish and Wildlife Service in the "Adopt A Wetlands" program. The program was begun by the TAMUCC Center for Coastal Studies in 1991. K-12 students are taught the importance of wetlands using a hands-on approach in which they adopt a wetland and make regular monitoring trips to collect data on wetland flora and fauna and water quality. Six teacher training workshops were held in 1996 and 125 teachers and 15,000 students are monitoring wetlands along the Texas Gulf Coast and in the High Plains.

The Edwards Aquifer Research and Data Center at SWTSU has developed many educational materials including *Stepping into Successful Science Teaching - an Instructional Manual and Activities Guide*. *Twenty-nine & One Creative Dramas of Texas Water Concerns* was written by Charles Pascoe and contains dramatic presentations teachers can use about irrigation, groundwater recharge, the Edwards Aquifer, and the water cycle. Center videotapes describe how water flows through the Edwards Aquifer and local rivers. The Center sponsors Aquatic Studies Field Days that

let teachers and students observe and study the Edwards Aquifer. Participants view endangered species at San Marcos and Comal Springs, take a boat ride over Spring Lake, and learn to take water quality and biological samples. The Center hosts Aquatic Studies Camps for youth aged 9-13 that are held over nine weeks each summer.

At UHCL, Jim Lester and Lynn Spachuk of the Environmental Institute of Houston are involved in many environmental education projects. "We train teachers how to take their students outside and find ways to utilize the outdoors," Lester says. "At schools with habitats, teachers and students see nature every day." The Institute, the U.S. Fish and Wildlife Service, TPWD, other agencies, and private groups, is helping schools develop habitats at their sites. So far, 35 public schools have developed schoolyard habitats consisting of native plants, ecosystem zones, and butterfly gardens. "Schools do the best job when kids help design and maintain sites and when teachers incorporate habitats into lesson plans," he says.

At the UT Marine Science Institute at Port Aransas, K-12 students and teachers can take part in a "visiting class" program where they are taught about coastal ecosystems and aquatic habitats and marine environments.

Other Projects

The Texas Environmental Center (TEC), a non-profit organization in Austin, advocates the use of computers to provide environmental education information. TEC developed a WWW version of the *Texas Environmental Almanac*, which includes sections on water supplies, and water quality. They publish a newsletter, *GreenBeat*, that publicizes success stories of youth involved in environmental activities. TEC is developing an interactive CD-ROM about Barton Springs, which will include digitized video interviews with water experts, historical photographs, and water quality information. "K-12 students should be encouraged to use computers for research," says TEC Director Marshall Frech. "We should supplement water resources education by telling stories. Computers are a great way of doing this."

The Texas Farm Bureau has created educational resources for K-12 teachers and students. Topics cover sustainable agriculture and soil, water, and habitat conservation. The Farm Bureau works with Tarleton State University to offer a Summer Agricultural Institute which provides teachers with a first-hand look at agricultural practices and natural resources issues.

The Lower Colorado River Authority (LCRA) has long been involved in many environmental education projects. They developed the first volunteer monitoring network in the state, "The Colorado River Watch" ("Texas Watch was modeled after it). LCRA was the first water supplier in Texas to develop the "Major Rivers" program, which is now used by LCRA, the Brazos River Authority, and other water suppliers. This program is geared to fourth graders and introduces students to water issues through a cartoon character, "Major Rivers," and his horse, "Aquifer." LCRA's "In Concert with the Environment" is a classroom curriculum that helps junior high school students learn

about how their use of energy and water resources impacts the environment. Roughly 4,700 students participated in the program and follow-up surveys found that 90% of students pledged to conserve natural resources. LCRA and TEC developed the "Tributary" BBS, which includes lessons, activities, subject areas, reference materials, and a forum where students and teachers can chat with water experts. LCRA involves students in water quality monitoring through its Colorado River Watch Network. Water quality data is gathered by 500 students from 30 schools.

The Harris-Galveston Coastal Subsidence District and The High Plains Underground Water Conservation District are using an education program that instructs youth in water conservation. The program, "Learning to be Water Wise and Water Efficient," was developed by the National Energy Foundation and teaches students how to conserve water through plumbing retrofits and fixing water leaks. It is offered by the Subsidence District to 34 school districts. Students receive a low-flow shower head, aerators for kitchen and bath faucets, and water conservation test kits. The Subsidence District provides water suppliers with a credit of 84,000 gallons of groundwater for each student who completes the program because water savings are anticipated. They estimate the 40,000 fifth graders who participated in the program in 1995 saved 672 million gallons of water. The High Plains District recently began a pilot project to provide this program to fifth grade teachers and students at four schools in its 15-county area. Two school districts have just completed the program while two others will teach it this spring.

The National 4-H Council developed an educational program titled "Environmental Stewardship: Tools for a Better World." This program contains curriculum materials on water quality, wetlands, and endangered species, and an interactive CD, "Operation Watershed," that helps players learn about non-point source pollution.

Sea World of Texas offers camps where students and teachers can learn about careers in the marine sciences, sharks, whales, and coastal ecology. Teacher and staff workshops are offered on marine and ocean sciences. The Texas State Aquarium in Corpus Christi offers educational programs including a beach walk where students can observe hermit crabs in their natural environment, learn about shoreline processes and beach erosion, and participate in scuba diving. Teacher workshops are offered on saltwater aquariums, techniques in kayaking, sailboating, and surfing, coral reef ecosystems, and circulation in the Gulf of Mexico.

Summary

Outstanding efforts are being carried out throughout Texas to increase water resources and environmental education and they should be applauded. It's hard to imagine something more important than teaching children about the need to care for water resources. Types of educational programs that are needed are ones that develop skills in critical subject areas (particularly mathematics and science) while inspiring students and creating in them a desire to want to learn more about the environment and care for it. Efforts are needed to evaluate the success of these programs in teaching children. The use

of the WWW and multimedia computer programs may be an important way to meet these needs.

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