Using Economics in the High School Science Curriculum to Solve Environmental Problems

by Mike Ellerbrock

This lesson plan for high school teachers illustrates how economic principles and incentives can be incorporated into environmental science courses. It is the second article in a three-part series aimed at demonstrating how the land grant university system, National Council on Economic Education network, and institutions like the Chicago Board of Trade, Chicago Mercantile Exchange, and The World Bank work cooperatively to assist schools in their economic education programs. The series' authors are members of the American Agricultural Economics Association Economic Education Committee.

Combatting environmental pollution: "There oughta be a ____!"

Take a high school class of science or social studies students on a field trip to an ugly site of environmental degradation and, upon witnessing the sad scene, the typical reaction will be, "There oughta be a law!" Such thinking is not unwise, but it probably reflects a common bias toward legal solutions to social problems. The reaction is so prevalent that some analysts say America has become a "litigious society."

Economists, on the other hand, often advocate market forces and financial incentives to influence people's behavior. Rather than reliance on laws that tend to mandate (or prohibit) specific actions by businesses and individual citizens, and thus require a large bureaucracy for monitoring and enforcement, economic forces to make polluters pay may offer a fairer, wiser, cheaper, and more direct strategy for protecting environmental quality. In other words, There oughta be a price!

Fairer, wiser, cheaper, more direct

When polluters must pay for their actions, the solution is fairer because companies with dirtier operations must pay larger costs than cleaner/greener firms (Burtraw). The system is wiser because it rewards managerial creativity, entrepreneurial innovation, and technological investment alternatives to reduce environmental degradation.

The economic solution costs society less because it avoids large public bureaucracies for detecting and punishing violators. Also, if administered properly—in a consistent and timely manner—the system is more direct because it ties dollars and cents to the daily actions and plans of companies and citizens.

Some qualifications

Making polluters pay depends on truthfulness in self-reporting and on the technical capability to take accurate measurements of actual pollution emissions. Measurements are feasible at many point-source sites (for example, factories, waste treatment facilities, utility plants), but more difficult for nonpoint sources (for example, farms, urban runoff). Also, in a few cases, such as highly toxic and/or radioactive materials, laws that mandate a zero-tolerance level can better protect people and nature.

Certain other conditions are also necessary for market-based strategies to work efficiently. Government needs to clearly specify and enforce who possesses what property rights over the land, air, and water, and ensure with some certainty that those rights will remain valid for the foreseeable future. Yet, whenever government makes such public choice decisions/allocations, fairness is always an issue: which individual or group benefits at whose expense? Economists also assert that the rules governing the trading of pollution permits, such as sulphur dioxide (SO_2) permits traded among utilities, need to be simple and that high "transaction costs," such as the expense of searching for and negotiating with trading partners, can inhibit trading (Stavins).

A short lesson plan

In designing a classroom unit on environmental economics, teachers can set the stage for economic concepts by posing a series of questions. First, ask a trick question of one or two students: identify on a large map the boundaries of a major body of water, forest, or some significant natural area, such as the Chesapeake Bay. If they point strictly to the shoreline around the bay, tell them that they are wrong.

A broader view

Help students develop a more holistic vision of the area in question, as well as of the entire biosphere. Focus on the need for an unbiased pursuit of truth about environmental issues and balanced social goals that harmonize the interrelationships and respect the dignity of all living creatures ("sustainable development"). Explain to students that a movement is occurring around the country to elevate extracurricular "environmental education" to the level of traditional "science education." The point is that we should base environmental policies and practices on a scientific understanding of ecological systems (Satchell). However, this raises a key question.

But, what are the sciences?

If we are going to design and conduct environmental education programs on a scientific basis, what are the relevant sciences? Ask students this question and note that most, if not all, will think of the natural sciences, such as biology, chemistry, physics, zoology, genetics, medicine, geology, hydrology, meteorology, earth science, astronomy, mathematics, engineering, and archeology. If the students respond with this list, tell them that they are only half right.

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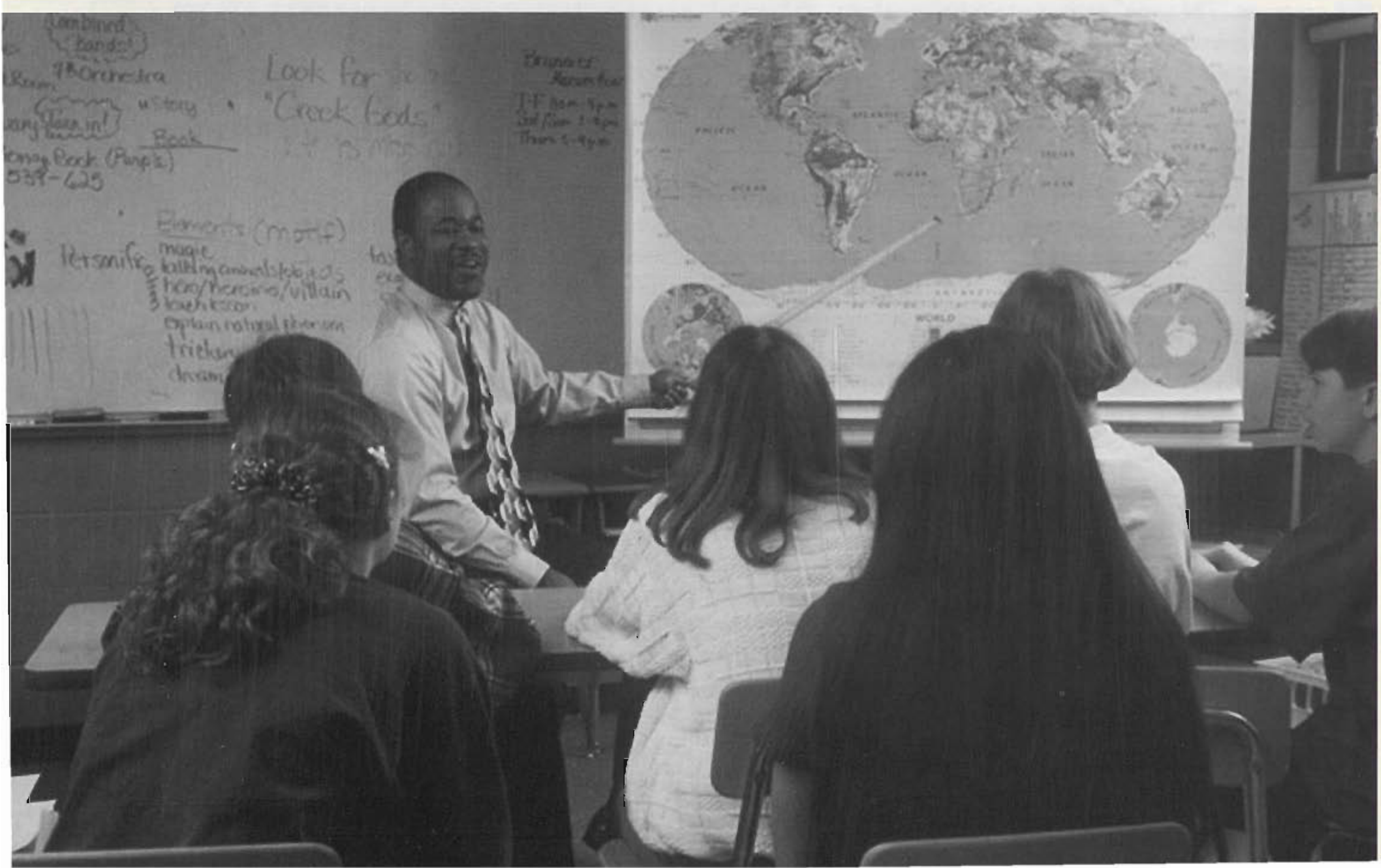
Point out that the social sciences, such as economics, sociology, psychology, philosophy, theology, political science, geography, anthropology, history, languages, art, music, and literature, can also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help solve environmental problems. Social sciences attempt to understand human beliefs, values, and behaviors that influence our relationships with the natural world. Thus, the social sciences are an essential part of formulating effective public policies that promote environmental quality. Now call some students back up to the map/screen and restate the question.

Now, where is the bay?

From a management perspective, the Chesapeake Bay's three-dimensional boundaries include the watersheds and airsheds that drain into the main water body. Point out how many people, cars, roads and paved parking lots, homes, buildings, factories, farms, utility plants, waste treatment facilities, mines, and forest operations lie within those broader boundaries. A similar situation exists around most large natural areas.

Encourage students to research and discuss the environmental impacts of the diverse mix of human activities surrounding a resource like the Chesapeake Bay. For example, (*a*) sewage treatment plants and farms can harm plant and animal life by releasing nitrogen and phosphorus particulates into streams and groundwater tables that infiltrate the bay, causing an explosive growth in plankton that, combined with sediment inflows from fields and construction sites, choke off sunlight to aquatic sea grasses, resulting in decreased diversity of wildlife and less productive oyster beds, which serve as key filtering and purifying agents of the bay's water; (*b*) urban storm water runoff systems carry petroleum drippings and tire rubber shavings from automobiles into the bay; and (*c*) air-borne sulphur dioxide (SO_2) particulate emissions from coal-burning power plants enter the bay as acid rain.

Explain to students that a movement is occurring around the country to elevate extracurricular "environmental education" to the level of traditional "science education."

A key concept: optimality

Economists assert that for most pollutants (other than highly toxic and/or radioactive materials) there is a socially optimal amount of the contaminant that can be allowed into the environment. The optimal amount depends on the assimilative capacity of the ecosystem affected, the marginal (incremental) costs of prevention and clean up, and the marginal (incremental) benefits of environmental quality. The point of optimality is reached when the marginal costs of further pollution abatement outweigh the benefits generated by such action. But, in actual practice, how can we "put a price on clean air" (Breck)?

Tradeable air pollution permits

Market incentives can be used to achieve optimality. One system requires polluters to purchase a permit for each unit of pollutant they emit into the water, land, or air. This is currently being done to control air pollution from utility plants.

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The 1990 amendments to the Clean Air Act established a flexible permit system for rationing the amount of SO_2 emissions from coal-fired electric utility plants. Designed by the U.S. Environmental Protection Agency (EPA) and the Environmental Defense Fund and conducted by the Chicago Board of Trade, the system emulates the free market—putting a price on clean air—by requiring utility plants to purchase a permit for each ton of SO_2, a primary contributor to acid rain, released into the atmosphere. By limiting the number of annual permits, a region can achieve its optimal level of air quality. When local utilities purchase permits, the firms pass some or all of the cost of the permits on to the ultimate cause of the problem—electricity customers, many of whom will respond by turning off some lights and taking shorter showers!

Administered by the EPA, the Clean Air Act limits the aggregate amount of residual emissions of firms located within designated "air quality control regions" of the country. After an initial auction to apportion permits, existing or aspiring firms can buy and sell permits from each other through a clearinghouse. To date, permit prices have ranged from $125–$450 each (*National Geographic*). If one firm tries to horde the available permits by purchasing a large number, the price of permits will rise, forcing other firms to purchase cleaner (low sulphur content) coal, invest in pollution control technology (e.g., scrubbers, precipitators, baghouses), and/or reduce their output of electricity. Also, individuals and environmental groups can purchase permits, further reducing air pollution. So far, the volume of trading has been modest due to high transactions costs (Stavins).

Water pollution permits?

In a few states, some areas have adopted nutrient permit trading systems to control nitrogen and phosphorus emissions into streams and groundwater tables (the Dillon Reservoir in Colorado, Fox River in Wisconsin, Tar-Pamlico Basin in North Carolina). Early results are promising, though the existence of nonpoint source polluters makes it challenging to design and administer a system that is fair and equitable to point-source polluters (Stephenson, Kerns, and Shabman). ■

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Mike Ellerbrock is associate professor of agricultural and applied economics and director of the Center for Economic Education at Virginia Tech.

■ For more information

An underutilized, yet symbiotic, relationship exists between primary and secondary schools and the land grant university system, which has a mission of teaching, research, and extension in fields related to agriculture (including environmental education), the life sciences (including flora, fauna, and fisheries), youth development (e.g., 4-H), human resources, community development, and public policy (domestic and international). These fields integrate both the natural and social sciences. Land grant universities offer high school graduates excellent college and career opportunities. Plus, campus-based faculty and local extension agents are available to help K–12 teachers develop integrated programs and curricula on a wide variety of topics. Phone numbers are available from the American Agricultural Economics Association at 515-233-3234. For information on programs and publications available through your state council on economic education, contact the National Council on Economic Education at 1-800-338-1192.