VIEWPOINT

Toward a Rationale for Recycling in Schools

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Like many people from Third World countries,[1] I experienced recycling as a cultural–economic phenomenon. For example, I cannot remember my parents ever buying me a commercially produced toy. It was the task of my brother and his friends to make toys for me from empty cans, wires, and other discarded materials. As children, we collected aluminum cans, copper wire, tin cans, scraps of metal, and paper cement bags to trade for soccer balls, school supplies, and treats from the local merchant.

Empty tin cans were a rarity in my small town. Because tin cans are more than 90% steel, many people transformed them into coffee pots, tea pots, or cups. They also used small tin cans to decorate wooden chests and furniture, and large tin drums to make doors for barns or even mirrors. Local governments also bought tin cans to use as planters for trees that were then distributed to farmers. When people shopped, they chose packaging that could be reused.[2]

Stephen Jay Gould (1989) wrote in a different context:

> In our world of material wealth, where so many broken items are thrown away rather than mended, we forget that most of the world fixes everything and discards nothing. Streets in crowded Indian cities . . . are often spotlessly clean because every item has value in reuse or resale. Scraps of paper are immediately scavenged; even cow pies remain but a few seconds on the street before they are collected for fuel and slapped against a wall to dry. I have never visited a place more fascinating than the recycling market of Nairobi—a true testimony to human ingenuity. Here, sandals are made from tires, bracelets from telephone wire, kerosene lamps from bisected tin cans, containers from scraps of metal, and cooking pots from the tops of oil drums. (p. 8)

Auto repair centers around the world vividly illustrate the wasteful versus resourceful reputation of technologically developed countries versus Third World countries. For example, in my town, when someone brought a car in for repair, the mechanic asked, "Would you like it to be repaired American style or Egyptian style?" "American style" meant replacing the damaged parts with new ones, whereas "Egyptian style" meant repairing the damaged parts as much as was possible. Most people asked (and still do) for the Egyptian style of repair. Increasingly, however, the global availability of oil, minerals, and natural gas has caused some Third World countries to become as wasteful in their consumption as modern industrial countries are. The bounty of prefabricated materials (and advancements in transportation technology) has also created a condition in which people forget how to repair equipment and produce "homemade" items. When energy and resources are abundant and available at low cost, "there is little economic incentive for conservation, so resources tend to be wasted, producing an additional increment of wastes above that which is inevitable" (Odum, 1975, p. 44).

The Cost of Waste

Modern industrial societies rely heavily upon nonrenewable energy and materials, such as fossil fuels and mineral ores. The shift of dependency from renewable resources ("reproductive usage"), which leaves the resource base intact, to nonrenewable resources, ("extractive usage") endangers the long-term viability of our species. To use popular jargon, we are draining the Earth's "capital" instead of living off the "interest." This is why recycling should be integrated into the daily cultural and socioeconomic character of society.

The concentration of industrial-caused pollutants has reached a critical level, although paradoxically, recycling costs are astronomical. For example, cleaning up and recycling water in large American cities requires "substantial amounts of fuel energy and tax dollars that have to be diverted from other uses to do this work"

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(Odum, 1975, p. 44). Sometimes it is cheaper, Odum has argued, "to let nature's hydrologic and photosynthetic systems (both of which run on solar energy) do most of this work of its own for free; but this is feasible only if there are no other large cities upstream and downstream [in our planet Earth]" (p. 44). Hence, cities placed along rivers—a desirable location for obvious reasons—are detrimental to nature's ability to recycle. Detrimental, at least, if we continue to abuse the rivers and water cycles.

A case in point is the occurrence of the largest inland petroleum spill in U.S. history in a ravine on a farm near Winchester, Virginia. The smoldering heat of burning tires "melted rubber and synthetics into oil, which flowed out at a rate of two hundred gallons per minute, creating the largest inland petroleum spill in U.S. history" (Stuller, 1994, p. 29). The uncontrolled fire burned for over 7 months, defeating the local fire companies, the National Guard, Coast Guard, Navy, Army Corps of Engineers, and the Environmental Protection Agency (EPA).

> [The] retained heat continued to convert the tires into oil—a process called pyrolysis. When mixed with water, the oil can easily wash into streams and rivers, or seep into ground water (Stuller, 1994, p. 29).

When goods are available in abundance, recycling costs increase, but in terms of the cost to the environment, recycling is ultimately "cheap" and certainly healthy for humans and other species. Indeed, with proper implementation, recycling can help boost the economy. At a conference focused on cleaning up the environment, Barry Commoner, director of the Center for the Biology of Natural Systems at Queens College, argued that waste recycling can generate jobs for low-income Chicago neighborhoods as well as benefit the environment. "A recycling program that collected 65 percent of reusable materials in the city would create 20,000 jobs and a payroll of $600 million, with a $1 billion impact on Chicago's economy" (Bukro, 1993, December 4).

The loss induced by wastefulness extends beyond the drain of natural resources—it creates a great absence in the collective psyche of our species.

An Artificial Gap

Modern technology has enabled many of us in industrial countries to control, to some extent, the effects of nature on our lives (barring natural disasters, of which we can at best hope to survive and at least apply our technology for rebuilding). Hydroponic science has also enabled us to produce almost any crop we want at any time and in any area. The benefits of such manipulation are obvious, but by incorporating such "control" into our everyday lives, we have created an artificial gap between ourselves and nature.

This "memory loss" of our relationship with nature is reinforced by the sharp decline of agricultural education in most urban and rural schools, a lack of coverage of plants in biology classes (Flannery, 1991; Hershey, 1992; Honey, 1987; National Research Council, 1992; Steward, 1967), as well as the decline of field biology from the biology curriculum in many colleges and universities in North America.

> (T)he vast majority of people on this crowded planet are confined to cities . . . [and every] department of biology has the potential for providing field experiences for all students, and for bringing those students in touch with the natural world (Cartor, 1993, pp. 140–141).

The earth is a great teacher, especially for those whose lifestyles are closely tied to its seasonal changes. I remember that during the windy and dusty summer seasons of my childhood, we did not go to school because we needed to help our parents farm the land. Fresh fruits and vegetables were not available year round. Like Americans before the industrial boom, we had to preserve and conserve our food resources, and we came to know that life follows a cycle from season to season and from birth to death. When everything follows a continuous cycle, the cycle becomes a recycle. Our schools reinforced this understanding by emphasizing the study of agriculture and plants—knowledge that children used after school in their families' farms and gardens.

Today, the seasonal changes are meaningless to many, except in terms of baseball, football, and basketball. Teachers should provide children with experiences that help them see the seasons, cycles, and recycling in the natural world, as well as realize that "regular recycling is not restricted to and necessarily merely for materials like carbon, oxygen, nitrogen, water and animals, but it involves overall life and death in order to perpetuate life as a phenomenon" (Atreya et al., 1985, p. 32). Tragically, however, only a few schools foster programs that help children attain such awareness, and agricultural education at the precollege level is nonexistent in many school districts in North America.

> Our students no longer tend gardens, go fishing or raise farm animals. . . . The hamburger or chicken fillets we eat bear no relationship to the live cow with the pretty brown eyes or the cute hen that wanders aimlessly pecking at food. . . . Our students can no longer relate to death. High school students have been known to miss three days of school because their cat or dog dies. The understanding of birth, life and death have lost their meaning in the industrialization and mechanization of our society. (Jones, 1989, p. 481)

All citizens should understand that living organisms require a variety of chemical elements and compounds such as water, oxygen, carbon, nitrogen, phosphorous, sulfur, and calcium in order to live and grow. These chemical elements are recycled through living and nonliving environments in a closed system. Life "would quickly end if such elements and compounds were used once, passing from the soil and atmosphere to plants and animals, and then disappeared because they had been used up" ((Ehrlich, 1990, March 18). This is why all the elements used by living organisms are continually recycled between organisms and the nonliving environment. "No single species could persist alone on the planet. It would eventually exhaust all the nutrients and have no way of converting its waste products into food; it would die" (Ehrlich, 1990, March 18).

Recycling Our Most Precious Resources

I still remember when farmers preferred to use manure rather than chemical fertilizers on their farms. They were afraid that chemical fertilizers could attract more or different worms, and this has been proven to be correct. They knew that the manure, which consisted of the remains of uneaten food, feces, and carcasses, could be broken down and disposed of by the biological process of decomposition. By contrast, they were suspicious of chemical fertilizers. Their great teachers—the land and the elderly—had never taught them about unnatural fertilizers.[3]

Nature recycles with remarkable efficiency. For example, the wide diversity of life forms enables a forest to recycle its organic matter so efficiently that it may require only a few resources from the soil. When we "overharvest" forests (and subsequently destroy them), we violate their laws—harmony and diversity—and we prevent life from regenerating and supporting other life. When we destroy the forests for lumber products and by-products, we also wreak havoc with the natural water cycle.

> Forests recycle moisture back into their immediate atmosphere by respiration where it again falls as rain. Transpiration return from an acre of forest may reach 2,500 gallons per day . . . and thus creates a natural system of water reuse. If the forest is removed, this natural reuse cycle is broken, and water is lost through rapid run-off. (Southwick, 1972, p. 68)

Water is a prime example of a vital resource that suffers pollution and waste to such an extent that it is at risk for being unable to support human life.

> There is only a certain amount of water on the planet. It is the same water that has "always" been here. It gets used over and over, processed and recycled, but it is the same water that the dinosaurs bathed in. No secret natural water machine is making more. There is no cosmic well or fountain of youth. So all the engineering, municipal water mains, sewer systems, industrial pumps and evaporation beds are finding more complex ways to process and reprocess a limited supply of most vital resources. (Rans, 1991, p. 10)

Evolution has created an ecosystem of symbiotic coherence. The waste of one organism becomes the food of another. The waste of a given production process is the raw material for another production process. For example, the carbon dioxide and water from respiration are released back into the environment where they are recycled into photosynthesis by autotrophs. Energy is not recycled, but the materials are used over and over again.

> Waste may be potentially harmful, but waste levels may be so small that they may be naturally recycled back into nature without danger to ecological systems or human beings—for example, cigarette smoke out of doors. Or waste may be of a type which makes it easy to recycle back into nature without harmful effect even if it exists in large quantities—for example, stubble from crops. In either case, the volume of waste (or byproducts of industry and consumption) which becomes highly concentrated spatially, sooner or later becomes pollution—in other words, natural recycling cannot occur. (O'Connor, 1989, p. 3)

As we all know, modern society as a whole not only fails to recycle, but also produces large volumes of toxic and nonreusable waste. Nature does not make substances, such as DDT, BHC, or PCB because living things reject them. As Paul Ehrlich (1990) explained in the remarkable television program "Earth":

> Unfortunately, humanity has learned to make substances that are not waste by the normal definition of nature. They combine elements that are not normally found combined in nature. For example, chlorine atoms attached to hydrocarbon atoms. Therefore, the microorganisms that normally break down the waste and reconvert them into nutrients are unfamiliar with new compounds and are unable to do the job. (March 18)

We need to implement recycling habits for renewable energy sources (e.g., sun, wind, and water) as well as nonrenewable sources (oil and natural gas). According to Asano and Mills (1990), recycling "has often been associated with non-renewable resources, but it must be recognized that water [for example], although the most renewable of our essential resources, is available in too limited a quantity to be used only once before being returned to the natural cycle" (p. 38). Thus, a systematic approach to waste water reclamation should be implemented all over the world. This could satisfy the high demand for water that often exceeds available reliable water supplies—even in areas with high rainfall.

In short, our environment provides us with a free service for our survival and we must receive this gift with grace and treat it with care or it will ultimately be "revoked" by the authority of the planet itself. Astronaut Taylor Wang understood this when he saw the earth from a distant spacecraft:

> I decided I would try to do what I could to help protect it. We are taking the Earth for granted. In reality, Earth has very limited resources. It has limited capability to recycle itself. If we [the inhabitants] do not help it, Earth will still be here. Earth will not go away, but we will go away. (Lemle, 1990, p. 4)

Recycling in Schools

If human societies are to win the struggle for ecological sustenance and overcome the natural tendency of matter toward entropy (disorder and death), we must understand our delicate ecosystem and the sources of our food, water, air, and shelter. Recycling can reach a level of collective consciousness only if we begin at the fundamental level—teaching our schoolchildren that it is an essential and natural mechanism that has created and sustained life on Earth.

However, as Orr (1992) argued, "The crisis cannot be solved by the same kind of education that helped create the problems" (p. 84). So that our children may thrive in the fast-paced technological world and ultimately overcome our self-induced threat to life, we need to add agriculture, nature, plant biology, field biology, geography, and ecology education to our general school curriculum. In addition, we should emphasize the teaching of recycling and show students real examples of recycling at all biological levels: from the molecular level to the biosphere. To do so, we need to reexamine our national priorities and our school curriculum in general and our biology, ecology, agriculture, and geography curricula in particular.

Major Objectives in Teaching Recycling

• Students need to understand that the resources of our planet are limited. When the volume of a given waste (or by-products of industry and consumption) becomes highly concentrated spatially, natural recycling cannot occur and it becomes pollution (poison) unless it is used (O'Connor, 1989, p. 3). Further, plastics and other synthetic polymers and radioactive waste will persist in the environment for hundreds of years. Hence, we should only produce the kind of waste that is familiar to nature.

• Matter's pathways (the way matter recycles itself) and the energy flow between living and nonliving systems are a regular and necessary phenomenon for the balance and continuity of nature, even though we do not always see the movement of these processes in our lifetimes. "The interaction(s) . . . between the various factors [in nature] are so smooth and often so slow that we are not particularly aware of the complexity of those interrelations until something goes wrong" (Atreya, 1985, p. 18). Hence, in the long run, no organism can live without an environment consisting of cycling and recycling.

• Concepts such as "economic growth," "sustainability"—living within the carrying capacity of the biosphere, "development"—the expectation of more, and "carrying capacity"—the ability of the biosphere to "assimilate waste, provide food and supply other resources" (Chirase, 1993, p. 71) should be introduced and critically examined.

• Students should understand the laws of entropy and thermodynamics and how these laws affect all living things. Students should understand that energy transformations in both biological and physical worlds are not 100% efficient; that the whole universe is tending toward a state of maximum entropy; and that in order to continue to function, "organisms must continue to receive new supplies of energy in the ecosystem" (Emmel, 1973, p. 25).

• Students should learn that our landfills are mostly composed of phone books, magazines, and other *recyclable* materials. This is indicative of how, at our present level of practice, we neglect proper recycling techniques (Rathje, 1991). We need to cultivate global ecological thinking, community action on local environmental issues, and organically oriented lifestyles, individually and collectively.

• Students should learn about the earth's natural "garbologists," such as earthworms and similar living organisms that use organic technology for recycling. Living organisms such as these feed on organic materials that consist of the remains of uneaten food, feces, and carcasses and can be broken down and disposed of by the biological process of decomposition.

Our recycling teaching objectives should ultimately aim toward active participation in solving our environmental problems. For example, we discard almost one quarter of a billion tires annually, and most of us do not know what happens to them. Fortunately, some tire discards are becoming a resource for various new and innovative individuals and companies, but we need to find new and better ways to recycle surplus tires (see Table 1). "Recycling fairs," for example, would encourage and reward innovative recycling processes and allow a public forum for ideas to implement new technology.

Conclusion

We have been told to recycle because recycling paper saves trees, and thus we should use less paper when possible . . . write or photocopy on both sides of the paper you use . . . request that merchants take you off their "junk mail" list . . . share catalogues and magazine subscriptions with your friends . . . buy recycled paper goods . . . demand for recycled paper must exist . . . buy in bulk to save money as well as paper . . . support businesses

TABLE 1. Conventional and Unconventional Use of Old Tires

Conventional
Some retired tires are retreaded and put back into service, but most people don't trust them for safety reasons.
Abandoned tires provide homes for vermin—this is good for them, but it's a serious health hazard for humans.
Modern playground equipment is often composed of old tires. Also, crumbled rubber from tires is used as substitute gravel for playgrounds.
Unconventional
Road construction crews shred tires to create artificial embankments along roadways.
Whole tires make good retaining walls to shore up eroding road shoulders.
Scrap tires can be combined with asphalt for use in paving roads.
Shredded tires are mixed with latex binders to create tile and mat floor coverings.
Oil is extracted from tires through the pyrolysis process.
Tires are filled with dirt and cemented into "bricks" to create energy-efficient walls for housing (solar earthship houses).
Tires are control-burned to generate electricity.
Discarded tires are mixed and "cooked" with limestone, shale, and sand at nearly 2,700° for about 45 min to produce porland cement.

Note. For further information, consult N. Grove, 1994, July, "Recycling," *National Geographic*, pp. 92–115 and J. Stuller, 1994, Burning rubber: Trashed tires rise from the ashes. *Destination Discovery. 10*(3), pp. 28–31.

that take action to reduce their use of paper . . . for a coffee or soda to go bring your own mug or reusable cup instead of getting a disposal paper container . . . treat your baby to the comfort and economy of cloth diapers instead of disposables . . . use recycled lumber where possible . . . recycle your own scrap wood too, . . . design before you buy . . . reuse wood around your house . . . boycott old-growth redwood, look for the good forest-keeping seal of approval . . . write to Congress . . . write to the Department of Commerce . . . etc. (Zuckerman, 1991, pp. 83-91)

These are methods by which personal involvement affects the wider spectrum of species survival. When students learn about recycling, not only will they gain the daunting knowledge of how destructive our present lifestyles are, they also will experience the liberating wisdom of how important the actions of each individual really are.

Education can make a difference. Our children need to learn that life has evolved for thousands of years because nature recycles with remarkable efficiency. Recycling has been and will continue to be one of the survival mechanisms in nature. This makes recycling a moral, ethical, and survival issue for human beings.

Our children need to learn that there is a deeper reason to recycle than just extending the life of landfills, lowering the cost of disposal, saving resources, or reducing pollution at the manufacturing stage (Poore, 1993). As human beings and members of the community of Earth, we must contribute to the maintenance of nature, life, and the survival of the planet. In order for our students to learn and understand this, we have to put nature back into education and make recycling a part of the school curriculum.

If we want to develop a society in which most of its members are recyclers, we cannot depend only on the media, even when it is an effective means of transmitting information about recycling. To ensure recycling behavior and higher participation in waste management, educators must design new strategies to incorporate a range of options that include teaching recycling and waste management in schools. From the earliest school years, students should be exposed to learning about recycling in the natural world. As Norman Cousins (Robbins, 1987, p. 19) once said, "Nothing is more powerful than an individual acting out of his conscience, thus helping to bring the collective conscience to life."

NOTES

1. The author was born in Sebha, a town at the northern edge of the Sahara Desert in Libya.
2. Such shopping behavior is now called *precycling*. Berkeley, California, is one of a growing number of communities that practices precycling methods in the United States.
3. In various Third World countries, to avoid using chemical fertilizers, many farmers and cattle or sheep ranchers kept their long-term ecomomically mutual relationship. "The latter were permitted to graze their cattle [or sheep] on the stubble on the former's farms in return for manure—the main source of fertilizer" (O'Connor, 1989, p. 5).

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APPENDIX

Further Tips for Instructors and Curriculum Designers

Some Examples of Key Questions for Students at Early Stages of their Education:

1. What is recycling?
2. Can you give an example of a circle or cycle in nature?
3. Why do we need to recycle?
4. What do we use as resources from the planet's ecosystem?
5. Is there a difference between how humans create shelters and how animals do?
6. Is there a relationship between the pathways of matter and the flow of energy through the living world?
7. How does recycling help with understanding balance in the environment and the sustainability in the ecosystem?
8. What is entropy? What kind of relationship exists between energy flow, material cycling, and entropy?
9. How can you environmentalize your life?
10. Do we need recycling for one or more of the following reasons:
    a) to extend the life of landfills?
    b) to bring down the cost of disposal?
    c) to save resources?
    d) to cut pollution at the manufacturing stage?
    e) because it's ethical?
11. How do earthworms and similar living organisms (earth's natural garbologists) help the planet earth maintain itself?

Key concepts of the cyclic nature of ecological systems might include:

1. Classification and analysis of garbage,
2. Understanding waste management,
3. Life cycles of garbage, and
4. Recycling in the sociocultural (human-made) environment, such as re-use for the original intent, treatment or addition of new materials and reuse for the original intent, or reuse for commercially different intents.
5. Practical application of recycling, for example, utilization of glass bottles that are returned to be refilled (reuse), crushed into cullet and melted down to make more glass (remanufactured), crushed and used as a base for a road (conversion or reclamation), or cut and made into a drinking glass (conversion or reclamation).