Spaceship Earth Revisited

Robert W. Pultorak

STUDENTS, YOUNG AND OLD, are frequently exposed to ideas, speculations, and materials referring to the Space Age. Beginning with the first orbiting satellite in 1957, science educators began a re-examination of their goals and objectives. New and revised curricula (e.g., Pennsylvania Department of Education 1973) and texts (e.g., Wolfe, *et al*., 1966; Trinklein and Huffer 1961) resulted from this process. Soon to follow was the motion picture industry with such recent productions as "Space Odyssey: 2001," "Close Encounters of the Third Kind," and a continuing variation of "Star Wars." Even television has produced "space" programs. "Star Trek" and "Battlestar Galactica" are shows that have enjoyed popular appeal and continue to attract a large number of viewers.

More recently, spaceships have been used as metaphors to help portray the uncertainty of human actions with respect to the Earth's environment. This article describes a science course that I have developed for undergraduate college students and which uses as its central theme a concept called "Spaceship Earth."

The Spaceship Earth Concept

Much has been written about the Spaceship Earth concept (Boulding 1966; Ward 1966; Pollard 1967; Fuller 1970; Mead 1970; Ehrlich and Harriman 1971; Sauer 1971; Hardin 1972; and Dawson 1973). In its abridged form the concept suggests that planet Earth is similar to a spaceship inasmuch as:

1. both possess finite room and finite resources, and
2. living things are dependent on life-support systems (air, water, food, etc.) for their continued survival.

From these two statements a potpourri of environmental science concepts, principles, and issues may be taught: conservation of forests, saving endangered species, overpopulation, disposal of nuclear wastes, and the rapid consumption of petroleum. Could you as a biology, chemistry, or physics instructor derive other manifest or inferred science principles relative to your discipline from these premises?

A Need For an Alternative

After teaching at a community college for several years, I had found that the student-perceived "hard sciences" of college biology, chemistry, and physics had little appeal or utility for nonscience majors who must take a science course to graduate. What could an art major, a business administration major, or the undeclared learner do with a knowledge of the function of intermembrane spheres on the cristae of mitochondria? Relevancy is needed. The Three Mile Island crisis, the health-related factors surrounding the dumping of hazardous wastes, and the weakened and wasted appearance of starving children in Cambodia have touched each one of us—faculty, students, senior citizens, homemakers, laborers, and practically every other passenger on Spaceship Earth.

A time had arrived for a change, not only in our relation with and to the Earth's environment, but for a science alternative that would help learners acquire science concepts and principles that would show how their activities could have an important effect on the balanced natural systems of our planetary spaceship.

The Spaceship Earth Course

Although the Spaceship Earth course was designed and implemented at a two-year county college located in

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southern New Jersey near Philadelphia, such a program does not have to be confined to post-secondary schools. An environmental science program can easily be incorporated into the offerings of a junior or senior high school in lieu of unimaginative and "watered-down" science courses frequently encountered in some schools.

My first decision in designing the program was to require that students participate in the learning process. Without stating the well-known advantages and disadvantages of self-paced, individualized instruction, I proceeded to develop learning packets, or student modules, as the primary focus for learning. Student modules are activity-oriented booklets that permit the student to become involved individually in the learning process. Upon completion of the module, the student takes a mini-test and moves to the next student module.

The first semester is concerned with those modules referring to the biotic components of Spaceship Earth (the second part of the Spaceship Earth concept). I believe that we feel kinship and compassion for other living things and that students are more comfortable with an initial biological approach. Abstractions, such as chemical formulas, mathematical computations, and the parts of the atom, I believe, disincline rather than attract students to most science courses. Recall that most of the learners scheduled for this course are not science majors. Within the background of an open Learning Center, the learners were provided with a schedule in which to complete the modules. Table 1 (lefthand column) lists the biotic student modules.

The first Spaceship Earth concept concentrates on space and resources for life, both abiotic factors in the environment. The second semester contains modules on air, water, toxic substances, and other interrelated topics. A list of the abiotic modules appears in table 1 (righthand column).

Each student module contains six sections:

1. *Rationale*—attempts to explain why the module is important and how it is related to the concept of Spaceship Earth.
2. *Estimated time for completion*—states the average amount of time needed to complete the module.
3. *Prerequisites*—lists topics learners should understand prior to beginning the module (e.g., substituting in mathematical formulas).
4. *Laboratory experience*—refers the learner to a laboratory exercise accompanying the module (see table 2).
5. *Learner objectives*—contains a list of objectives students are expected to complete.
6. *Learning activities*—a sequence of learning experiences that will help the student complete the objectives.

TABLE 1. Student Modules

Biotic Modules	*Abiotic Modules*
Our Spaceship Earth:	Energy Sources:
1. The Spaceship Earth concept	1. Fossil fuels
2. Game simulation: Pollution	2. Nuclear energy
3. Laws on Spaceship Earth	3. Energy alternatives
Principles of Ecology:	Air and Man:
4. The concept of an ecosystem	4. Sources of air pollution
5. The flow of energy and matter	5. Smog
6. Natural populations	6. Effects of air pollution
7. Natural communities	7. Control of air pollution
Forest Conservation:	Water and Man:
9. Forests of the United States	8. Water resources
10. The value of forests	9. Water pollution
11. Forest conservation	10. Eutrophication
Wildlife Preservation:	11. Water treatment
12. Extinction of wildlife	12. Thermal pollution
13. Endangered species	Land Use and Abuse:
14. Introduced wildlife	13. Noise pollution
15. Saving wildlife	14. Solid wastes
The Population Problem:	15. Mineral resources
16. The population crisis	16. Land planning
17. Demography	Toxic Substances:
18. Reducing the world's population	17. Metallic and organic poison
The Food and Hunger Problem:	18. Food additives
19. The food crisis	19. Pesticides and herbicides
20. Ecology and the food problem	Ocean and Man:
21. Nutrition	20. Ocean ecology
22. Increasing the world's food supply	21. Ocean dumping
	22. Oil spills

TABLE 2. Laboratory Experiences

1. Laws of thermodynamics
2. An aquarium ecosystem
3. The hydrologic cycle
4. A population of yeast cells
5. FIELD TRIP: An old field community
6. The use of keys for tree identification
7. FIELD TRIP: Parvin State Forest
8. FIELD TRIP: The Philadelphia Zoo
9. A method for determining the size of a wildlife population
10. A correlation study of two variables
11. Increasing the world's food supply: conversion of cellulose
12. A simulation of radioactive decay
13. FIELD TRIP: Salem Nuclear Generating Plant
14. Sampling and analysis of air pollutants
15. Collection and identification of particulates
16. Thermal inversions
17. Determining vital capacity
18. Simulation of a polluted lake
19. FIELD TRIP: Gloucester County Sewage Treatment Authority
20. Incineration of PVC packaging material
21. A motor task and noise pollution
22. The determination of lead in household items
23. Vitamin C in foods
24. FIELD TRIP: The Wetlands Institute
25. Simulation of an oil spill
26. Extended labs
    a. Comparative study of personal nutrition
    b. Energy conservation
    c. Domestic or personal use of water
    d. Testing for water quality (with microcomputer)

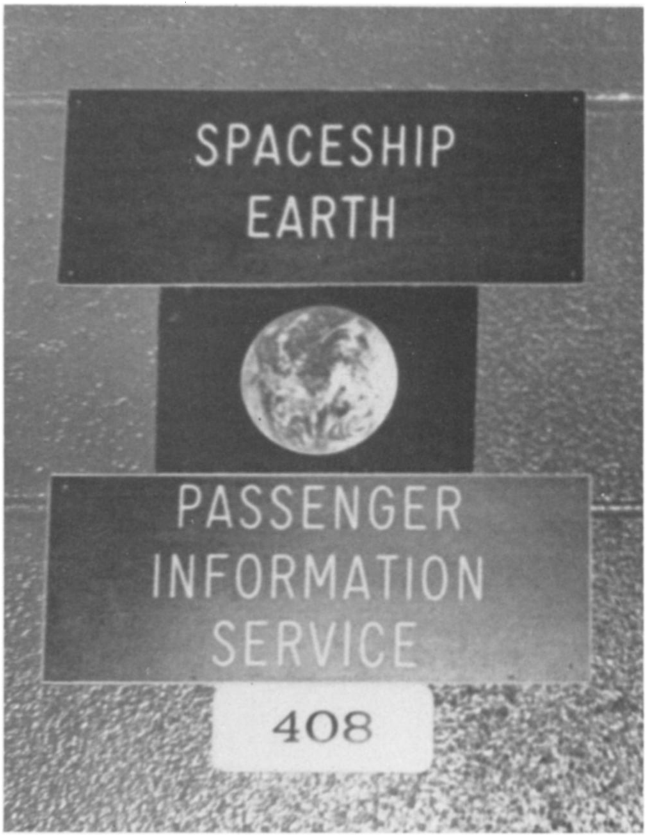

FIGURE 1. Entrance to Learning Center.

In order to reduce the boredom and passivity that is characteristic of many lectures, a number of conventional and innovative instructional procedures were used in modules to provide an assortment of learning modes to fit a diverse student population. Several examples are provided in table 3.

TABLE 3. Learning Activities

1. Use of text and audio-tape presentations
2. Laboratory experiences
3. Field trips
4. Demonstration materials with instruction cards for use
5. Collect data for surveys and interpret results
6. Participate in various simulation activities (e.g. games, labs, etc.)
7. Review basic science concepts through the use of filmstrips, filmloops, and self-teaching learning packets
8. Use of the library for research
9. Participate in values clarification exercises
10. Read journal articles and answer accompanying questions
11. Interpret meanings of graphs
12. Solve problems involving a practical application of mathematics
13. Simulations with microcomputer

The Spaceship Earth Environment

Although the instructional portion of the program provided the connection between science concepts and principles and the Spaceship Earth concept, there was still something missing—the aura or setting for Spaceship Earth.

To capture the feeling of a spacecraft while the student is learning, a number of instructional items and procedures were related to space travel. Figure 1 shows a plaque outside the door of the Learning Center. All are welcome. Initially, the windowless Learning Center was furnished with a number of large murals depicting Spaceship Earth's environment, such as deciduous forest scenes (fig. 2) and a mural illustrating the guiding concept of the program—Earth suspended in black void of space as was seen from the moon's surface (fig. 3).

Written material uses spaceship terms. The text is referred to as a flight manual. Ostensibly, the text provides information necessary to insure a continued, orderly flight for Spaceship Earth. *A General Flight Information Guide* is a booklet that contains the guidelines for the learners—the "crew"—to steer their own way through the course. *A Flight Schedule* is a table containing the names of the modules, the dates for their completion, large group-meeting topics and dates, and scheduled field trips.

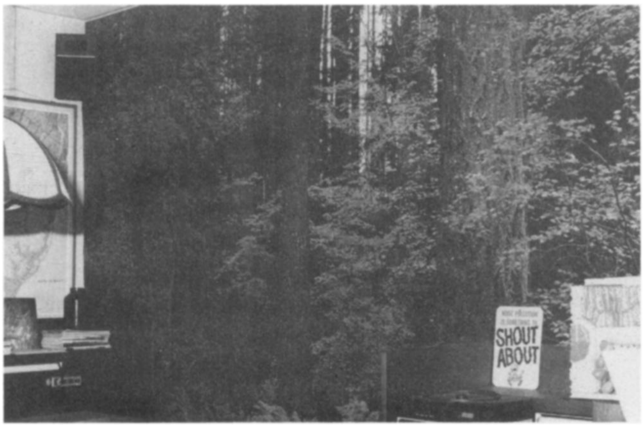

FIGURE 2. Wall mural in Learning Center depicting forest scene.

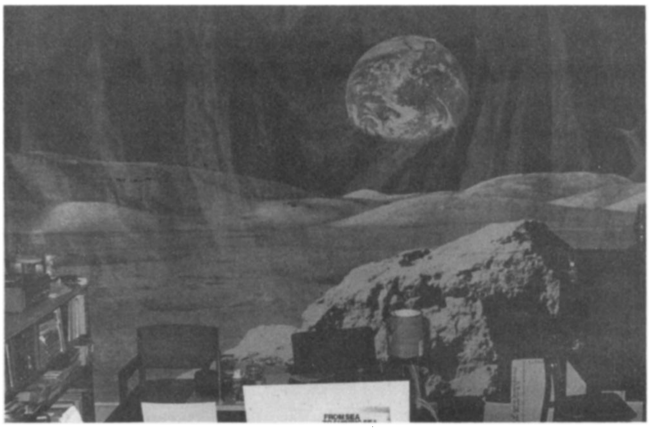
FIGURE 3. Wall mural showing Spaceship Earth from the moon's surface.

PIM Sessions

Since the Spaceship Earth program is self-paced, no attendance record needs to be maintained. However, a difficulty with this type of arrangement is that there is no time for all of the learners to be together at one time. Frequently announcements, data from the labs, and survey results need to be presented to the group. This problem is alleviated with what I call the PIM (Passenger Information Meeting) session. These sessions are held in a small auditorium, and each student is required to attend (the only required attendance) and meet as a representative complement of Spaceship Earth.

Though announcements and lab and survey results are presented during these sessions, this is not the primary mission of the weekly PIM session. Relevant environmental films are shown, speakers lecture, and field trips take place. Each meeting exposes students to a variety of issues related to environmental science. For example, at one PIM session, an authority on mercury poisoning gave a talk on his research and its implications.

Conclusion

We live in an era in which we have not yet become fully aware of the effects of our actions on the environment, including our responsibility to the planetary spaceship on which we are passengers.

Martin (1978) suggests a need for environmental education using the metaphor of Spaceship Earth when he asks:

> ...could the officers and crew of the Earth be excessively reluctant to alarm the passengers, and not cautious enough about the fate and condition of the ship?

I believe a science offering such as the one described in this article will help learners to become more mindful of their obligations to the environment, to one another, and to the yet unknown future. Former U.N. Ambassador Adlai E. Stevenson (1965) poignantly expressed for all the perilous voyage of Spaceship Earth:

> We travel together, passengers on a little space ship, dependent on its vulnerable reserves of air and soil; all committed for our safety to its security and peace; preserved from annihilation only by the care, the work, and I will say the love we give our fragile craft. We cannot maintain it half fortunate, half miserable, half confident, half despairing, half slave—to the ancient enemies of man—half free in a liberation of resources undreamed of until this day. No craft, no crew can travel safely with such vast contradictions. On their resolution depends the survival of us all.

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