ENERGY AND ENVIRONMENTAL QUALITY GAMES AND SIMULATIONS
An Evaluation

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INTRODUCTION

Earth Day, 1970, has been recognized generally as the dawning of our society's awareness of man's impact on the fragile life-support systems of Spaceship Earth. Yet, aside from the avalanche of rhetoric since then, it appears that we have progressed but a short distance from awareness of the problems to a concerted action directed at their solutions. Environmentalists, responsible for sounding the first alarm, have been involved in countless high-speed, head-on collisions with the proponents of growth, generating much heat (low quality) yet little light and an enormous credibility gap for the public at large.

During past crises, society has turned toward educators for help in changing attitudes, in preparing students for new roles in the work force, and in adapting to new ethics and behaviors consistent with changing societal goals, needs, and policies. The latest summons for help is the energy/environmental dilemma, seen by many to be a precursor of a series of worsening crises, impacting all sectors and aspects of society for the next several decades. But school districts themselves have fallen victim to inexorably increasing energy costs, having paid out $2 billion more for their energy in 1977 than they did in 1973.

It has become increasingly evident in the past several years that energy and environment must become central themes in all disciplines and at all grade levels—from science to home economics and from kindergarten through adulthood. So, you might ask, "Is there an effective way of teaching concepts, analyzing attitudes and viewpoints, and promoting individual values related to a positive energy/environment ethic?"

If you have had experiences with environmental simulations and games, you probably already know that this instructional strategy holds considerable promise and may be most appropriate for teaching the complex, interdependent, and cross-disciplinary facets of energy/environmental education. Yet the explosion in environmental energy literature and rhetoric is paralleled by an incredible increase in educational simulations dealing with this topic. With so many simulations and games from which to choose, how can you find the ones most suitable for your students' needs? Which ones are really outstanding, and which of those best meet your objectives? This leads us to the purpose of this essay.

Purpose

In this essay we will compare, contrast, evaluate, and rate eight of the best environmental quality/energy simulation games according to several criteria, including the most important: observation of actual play under conditions prescribed by the game developers. We will examine closely the realism of the simulation or game, that is, is the game situation an acceptable model of its real-life counterpart? We will look at cost factors, the issues considered, playing time, age level, and the rest of the evaluative gamut in an effort to aid you in your decisions.

Definition

Environmental simulation games, in general, are instructional strategies that purportedly model a system or systems related to population, resources (including food and energy), and environmental quality for learning or training purposes. Subsets of environmental simulation games, the environmental quality and energy games, emphasize the environmental impacts of collective human activities on the ecosphere and attempt to make players familiar with the many issues, attitudes, and facts involved in solving problems related to air and water pollution, energy production, and demand and resource depletion.

Table 1 alphabetically lists and briefly describes the eight environmental quality and energy simulation games selected for analysis in this essay.

Uses

If you are an educator, are affiliated with a community or governmental agency, or work with a grass-roots environmental/legislative organization, you will find these simulation games appropriate for the following applications:

(a) As a *teaching/learning strategy* in which participants learn about real-life environmental issues by reacting to a model, making related decisions, and checking the outcomes and impacts of those decisions;

(b) as a *communications/interaction sensitizing tool* that effectively brings participants with different backgrounds or perspectives on the issues together to share other points of view and to empathize with others, thus paving a path toward future cooperation.

Selection Criteria

The eight games we have chosen represent the gamut of general concepts inherent in the environmental quality and energy controversies. They are commercially available and have been so for a number of years; thus, they have all been played and evaluated (at least by the developers) a number of times. With one exception, they are priced at less than $30.00. Finally, they appear to facilitate the kinds of interactions necessary to a basic understanding of the central issues with audiences ranging from secondary classes to adults, with little modification. Although there are many fine environmental simulations designed for use with a computer, we felt that, because many groups have no easy computer access, we would omit these simulations from this discussion.

TABLE 1 The Eight Energy/Environment Quality Simulation Games

Simulation Game	Summary Description
Dead River	Players as private and public officials, selected as members of a regional water council, propose water quality standards for the restoration of an interstate waterway based on their own needs and economics.
Energy-Environment Game	Players as members of the "Governor's Commission on Energy and the Environment" represent conservationists, the utilities, and lay sectors of a region, and assess the needs for additional power facilities
Energy-X	Players as "special advisers to the President" represent various regions of the country in an attempt to allocate, according to region needs, a finite quantity of the hypothetical energy source, Energy X, found in a large meteorite.
Gomston	Players as representatives of local and state agencies attempt to clean up a hypothetical city plagued by severe pollution problems
No Dam Action	Players as representatives of county and state agencies deal with the problems and issues related to flood control of a local river.
Pollution	Players as factory owners and members of community councils attempt to maximize profits while minimizing air, water, and noise pollution in a farm-town region.
Pollution Game	Players as influential citizens make decisions and initiate actions related to minimizing air and water pollution while maximizing profits.
Pollution-Negotiating A Clean Environment	Players representing business, government, citizens, and conservation interests negotiate to obtain a quality environment while still satisfying personal and/or corporate goals.

PRELIMINARY CONSIDERATIONS

Basic Factors

In choosing a suitable simulation or game for your class or group, you should consider three basic factors: age/grade level, group size, and the amount of time you are willing to devote to the activity. Additionally, you need to know the basic format; that is, is it a "board" game, which restricts the number of participants who may gather around a single playing area and necessitates the use of multiple copies for a group, or is it a "class" game in which an entire group uses one copy?

Table 2 summarizes these factors for each of the eight simulations. Although each simulation or game is flexible within limits for each of the factors, use Table 2 as a basic guide. (Our analyses may vary slightly from individual instruction manuals or from synopses found elsewhere in the *Guide*.)

Complexity

We have ranked the simulations and games according to complexity in Table 3. Generally, reading level determines complexity; games with little or no reading are best suited for the junior high/middle school grade levels, while games concentrating heavily on reading comprehension are best for senior high, college, and adult groups. Your group's mathematical ability (computational, chart and graph interpretation) may, simultaneously, limit a game's suitability. Additionally, games that are loosely structured and open-ended or that

TABLE 2 Preliminary Considerations

Simulation Game	Format*	Grade Level	Playing Time (hrs)	Number of Players	Number of Subgroups
Dead River	C	10-12, college, adult	4-5	10-30	5-6
Energy-Environment Game	C	10-12, college, adult	5-7	20-40	4
Energy-X	C	9-12, college, adult	4-5	20-40	9
Gomston	C	8-12, college, adult	5-6	10-40	10-13
No Dam Action	C	10-12, college, adult	7-9	12-30+	12
Pollution	B	7-9	½-1½	12-16/Board	**
Pollution Game	B	7-9	3/4-1½	4 Board	--
Pollution-Negotiating A Clean Environment	C	7-12, college, adult	1-3	4-32	4

*B = Board Game, C = Class Game

**The number of subgroups will vary in the case of board games, depending upon the availability of extra copies of the game. For class games, these numbers of ranges indicate the number of subgoups into which the players are divided.

model complicated processes are most appropriate for more mature audiences. Table 3 takes these factors into account, showing ascending order of complexity within the given categories.

TABLE 3 Complexity*

Simple	Moderate	Complex
Pollution Game	*Gomston*	*Energy-Environment Game*
Pollution	*Energy-X*	*No Dam Action*
	Dead River	
	Pollution-Negotiating A Clean Environment	

*Titles listed in descending order of complexity within columns.

ISSUES

Perhaps there are particular issues you would like your group to confront, or perhaps you want a simulation game that will allow your students to react to a number of environmental issues simultaneously. Table 4 is a breakdown of all the issues many environmental educators consider essential for a general exposure to the environmental quality and energy controversies. Please note that there is considerable overlap and that issues may be treated more or less significantly by different simulation games.

You may use Table 4 in two ways, depending on your objectives:

(1) Do you wish to use a simulation game that offers

TABLE 4 Issues

Issues	*Dead River*	*Energy-Environment Game*	*Energy-X*	*Gomston*	*No Dam Action*	*Pollution*	*Pollution Game*	*Pollution—NCE*	Totals
Environmental Quality									EQ
aesthetics	X	X		X	X	X		X	6
air quality		X		X		X	X	X	5
flood control					X			X	2
land erosion				X				X	2
land use		X			X			X	3
noise						X			1
policy	X			X	X	X			4
population impact		X	X	X				X	4
preservation		X							1
timbering								X	1
transportation			X	X			X		3
solid waste	X			X				X	3
urban environment		X			X				5
eutrophication	X			X					2
chemical pollution	X	X		X		X	X	X	6
thermal pollution	X	X		X	X		X	X	6
management	X			X	X		X		4
recreation	X				X		X		3
Energy									E
alternative sources		X	X						2
fossil fuel plants		X		X					2
nuclear energy		X					X	X	3
policy		X	X						2
plant sitings		X							1
resources/depletion		X	X					X	3
radioactive waste									0
consumption patterns			X						1
supply/demand		X	X						2
growth projections			X						1
electrical consumption		X	X						2
Related Economics									ECON
cost/benefit	X	X	X	X	X	X			6
economies of scale		X	X		X			X	4
supply/demand			X		X				2
abatement taxation	X			X		X	X	X	5
trade-offs	X	X	X	X	X		X	X	7
employment				X					1
TOTAL NUMBER OF ISSUES CONSIDERED	11	19	13	16	13	7	12	16	35
PERCENTAGE	31	54	37	46	37	20	34	46	100

exposure to a large number of environmental quality and energy issues?

If so, read down the simulation game columns. Note, for instance, that the *Energy-Environment Game* includes coverage of over 50 percent of the issues listed; in contrast, *Pollution* incorporates only 20 percent of the issues.

(2) Do you wish to locate simulation games that address a specific issue of interest to you and your students?

If so, read across the issue rows. For example, if your target issue is "aesthetics," you will have little difficulty in finding appropriate simulations that address this issue, since six of the eight incorporated "aesthetics." However, should your target be "radioactive waste," you will note that none of the eight focuses on this topic. Omission of this issue in energy simulation games is inexcusable given its potential impact in the social and environmental realms, and it should be addressed by simulation developers.

In view of the numbers of environmental quality and energy issues covered, we consider the *Energy–Environment Game, Gomston,* and *Pollution–Negotiating a Clean Environment* to offer very good coverage of representative issues in environmental/energy education.

TABLE 5 Depth of Content*

Low	Moderate	High
Pollution-Negotiating A Clean Environment	*Dead River*	*No Dam Action*
Pollution Game	*Gomston*	*Energy-X*
Pollution	*Energy-Environment Game*	

*A simulation or game with low depth of content includes from one to three pages of content-related information in the instruction guides for teachers and/or students; moderate, four to six pages; high, more than six pages (including bibliographies and audiovisual materials). Titles are listed in descending order of depth within columns.

CONTENT

Cognitive Base

One of the primary concerns of every educator who uses simulation games is the depth of content the activity provides. You must decide whether you wish to stress information, process, the affective realm, or a reasonable balance. Are you interested in a simulation or game with a heavy emphasis on environmental "facts" or one that will provide a cursory introduction to the issues? Table 5 can give you some useful guidelines.

Affective Base

Research indicates that the affective realm may be the forte of simulation games. Perhaps you want your students to be exposed to different attitudes, viewpoints, and values related to energy and environmental quality. To help them understand the range of attitudes that surrounds any given environmental issue, you might want to choose a simulation whose model includes a diversity of conflicting points of view and values: for example, business/industry versus environmentalism versus citizen views, or wildlife manager versus the polluter.

Perhaps the most significant value, among several that occur repeatedly in most of the eight simulations, relates to the free enterprise system and how its success and future are dependent on compromises (tradeoffs) among environmentalists, industry representatives, business managers, and law makers. Most of the simulations present this value implicitly in the game process; a few (for example, *Energy-Environment Game, No Dam Action,* and *Gomston*) treat it explicitly by explaining its significance on several role profile cards and by urging players to adopt the value in their roles. Either way, students begin to recognize the value of the free enterprise system in our society and its interdependence with environmental quality and economics.

The *Energy-Environment Game,* in our opinion, does the best job of introducing values, viewpoints, and attitudes related to the energy/environment crisis, accomplishing this task, in part, through filmstrip/tape cassette interviews with six people who view the environmental quality/energy dilemma from quite different perspectives.

Other, more traditional, values that appear to a greater or lesser extent in this collection of simulation games include those inherent in the philosophies of "bigger is better," "growth is good," "maximum good for the greatest number," and "preserve the environment at all costs." Of course, these are real values held in society, and the conflicts arising from them emerge in natural, uncontrived ways in most of these simulations.

Once the values were dissected into their elements during the normal course of play, we found that students often were able to rebuild a more positive environmental ethic from them. This ethic usually emerged in the debriefing sessions, and several components of it were easy to discern:

(1) Except for a continuous supply of sunshine, "Spaceship Earth" must complete its journey using the "supplies" placed on board when it was "launched."

(2) Human beings cannot perform one action without some consequence(s) of that action occurring somewhere else in the ecosphere.

(3) Mankind is a *part of* many overlapping ecosystems, is subject to their governing principles, and should not be considered separately from them.

(4) Everything must go somewhere, and nothing is "free."

(5) Uncontrolled growth on a planet of finite resources cannot be long sustained; therefore, more controls can be expected to be imposed on our free enterprise system.

We consider the promotion of this kind of environmental ethic to be one of the fundamental criteria for success in environmental quality/energy simulations. Table 6 rates each game according to the estimated percentage of game time spent on clarification of these values and on the development of this kind of ethic.

TABLE 6 Percentage of Time Allocated to Affective Considerations

Low (0-10%)	Adequate (11-25%)	Moderate (26-75%)	High (over 75%)
Pollution	*Energy-X*	*Dead River*	*Energy-Environment Game*
Pollution Game		*Pollution-Negotiating Game*	*No Dam Action*
		A Clean Environment	
		Gomston	

ROLE-PLAYING

Here are additional questions you need to resolve before choosing the right simulation game for your needs. If the simulation game you are considering includes provisions for participants to assume roles, what kinds of roles are included? Does each participant respresent another individual, a group of individuals, or is his or her participation purely functional (that is, is the participant given a separate assignment with special rules)? How structured are the roles? How open-ended are they?

Consider these examples:

(1) Individual Role: Regional Director, Universe Club (*Energy-Environment Game*)

"You are a sociology professor at the State University, but a major portion of your time is devoted to being Regional Director of the Universe Club. You feel your duty is to lead the club on "battles" against major contributors to environmental damage, particularly the public utility companies. The pollution they generate from fossil-fueled plants is clearly a legitimate target for your attack. Of course, you are quite violently opposed to nuclear plants as well."

(2) Group Role: Steel and Chemicals (*Gomston*)

"Congratulations! You are the representatives of the steel and chemical firms in the Gomston area. As you know your firms are causing much of the air and water pollution in and around Gomston. Even though you must resolve your own pollution problems by installing new equipment and techniques, it might be wise for you to draw attention away from yourselves by attacking the other groups for doing very little about their pollution."

(3) Functional Role: (*No Dam Action*)

"In *No Dam Action*, there is a variety of groups, from formal decision-making groups to largely policy-oriented groups. While each group has its own frame of reference and purpose, these junctions dominate:

- create study groups or task forces
- issue news releases
- conduct elections or replace resigned officials
- organize petitions
- keeping track of scoring data."

Table 7 indicates the kinds of roles in each of the simulation games.

TABLE 7 Kinds of Roles

Individual	Group	Group, Functional	Individual, Group, Functional
*Pollution Game***	*Pollution-Negotiating Environment*	*Gomston*	*No Dam Action*
Energy-Environment Game	*Energy-X*		
*Pollution***	*Dead River*		

**No Dam Action* includes individual, group, and functional roles with considerable overlap.
**Students play the roles of influential citizens, but the game includes no role descriptions. However, participants may write their own, if so desired.

The large diversity of roles the eight simulations represent is indicated in Table 8 by role title.

TABLE 8 Role Diversity

Simulation Game	Titles of Roles Included
Dead River	Taxpayers Association State Eco-Action Agency Federal Environmental Policy Agency Regional industry Valley Recreational Development Association
Energy-Environment Game	Governor's Commission on Energy & Environment Electric power company officials Lay citizens Conservation & Environmental Agency representatives Commerce, industry, and professional respresentatives
Energy-X	Project control officials Representatives of eight U.S. geographic areas
Gomston	Mayor City officials Coal, petroleum industry representatives Transportation agency Steel, chemical representatives Utilities' representatives Antipollution group Agriculture, lumber interests Forestry, wildlife officials Chamber of Commerce News media Local geographer State government officials
No Dam Action	Representatives from the following interests: utilities mining paper & chemicals Army Corps of Engineers health office law university engineering journalism religion

Table 8 Role Diversity (Cont)

Simulation Game	Titles of Roles Included
	labor
	sanitation
	banking
	real estate
	forestry
	local businesses
	accounting
	farming
Pollution	Community representatives
	Factory owners
Pollution Game	Influential citizens
Pollution-Negotiating A Clean Environment	Business representatives
	Governmental agencies
	Citizens
	Conservation groups

Role Structure/Flexibility

Depending on your purposes and your students' maturity levels, you may wish to choose a simulation with more or less role structure. For example, if you want your students to develop a close empathy with persons represented by the role profiles, you will need to choose simulation with highly structured role profiles. On the other hand, if you want a high degree of flexibility and open-endedness, you will want to select simulation with less structured, less-developed role profiles. You might also have your students design their own role profile cards for the less structured simulations or to augment the diversity of roles in those that are more structured.

Table 9 indicates the degree of structure and role flexibility inherent in the role descriptions of each simulation game.

Role Interest Levels

A criticism we found recurring quite frequently is related to those simulations listed in the first column of Table 9. Many students in the age groups recommended by the developers do not have sufficient background to play an unstructured role adequately. We found that unless the game facilitator supplied additional role information to the participants, play proceeded in a rather chaotic, disorganized manner. Our experience indicates that younger players, especially, appreciate a high degree of structure, because most have little or no preconceived notion of the responsibilities, viewpoints, attitudes, and values espoused by a prototypical role profile.

Additionally, since the effectiveness of most role-play simulations is greatly enhanced if players can assume roles that are divorced from their own identities, we found that allowing players to wear tags with names they made up provided an enthusiasm that helped carry the game process over rough spots. Most of the games do not provide name tags, although some do provide name plates that carry the title of the group or agency represented. Even for those simulations with a high degree of role structure, we would advise the facilitator to allow players to "refine" their roles by providing details (for instance, hypothetical names, marital status, number of children, aspirations, and so on) that do not appear on the profile cards.

TABLE 9 Role Structure/Flexibility*

Low Structure High Flexibility	Moderate Structure and Flexibility	High Structure Low Flexibility
Pollution	*Energy-X*	*Energy-Environment Game*
Pollution Game	*Gomston*	*No Dam Action*
Pollution-Negotiating A Clean Environment	*Dead River*	

*Titles listed in descending order within columns.

Unfortunately, even though a simulation may provide role structure adequate for your needs, there is no guarantee that students will find the roles interesting. And if the roles are boring and unexciting, players cannot be expected to portray them with enthusiasm. This will detract from your instructional objectives and ultimately doom a simulation game to failure.

Our observations of and interactions with players involved with the eight energy and environmental quality simulations indicate the following:

(1) Players new to the simulation technique appear to generate more interest and enthusiasm (and, by inference, more direct learning) with simulations exhibiting a moderate to high degree of role structure.

(2) Older, more experienced students seem to appreciate more latitude in the structure of the roles they assume.

Accordingly, Table 10 presents the interest factor inherent in the roles associated with each of the simulations. (Our test groups may not be representative of other student groups, so you should use our judgments only as rough guidelines.)

TABLE 10 Interest Levels of Roles*

Low (Least Enjoyable)	Average	Above Average	High (Most Enjoyable)
Pollution	*Pollution-Negotiation A Clean Environment*	*Dead River*	*Energy-Environment Game*
Pollution Game		*Gomston*	*No Dam Action*
		Energy-X	

*Titles listed in descending order within columns.

RULES

Clarity, Organization, and Comprehensiveness

One of the most important of your considerations deals with the game manual. How organized, how complete, and how clear is the presentation of the procedures you must follow? In most cases the rules are outlined in the facilitator's manual. In a few simulations, however, you may find procedures and instructions listed on the players' role profiles, on the backs of name plates, or in special "Players' Manual." Although it is not necessary (or possible) for manuals to cover every situation with a specific rule, instructors usually want comprehensive treatment so they can make spur of the mom-

TABLE 11 Manual Ratings, Procedures, and Preparation Time

Simulation Games	Overall rating of manual for clarity, organization, completeness. Total number of pages in manual appear in parentheses.			Number of pages devoted to procedures	Preparation Time (Hrs)
	Adequate	Good	Outstanding		
*Dead River**	X (20)			3	2 3
*Energy-Environment**			X (28)	18	3-4
Energy-X			X (8)	4	1½-2
Gomston			X (24)	5	2-2½
No Dam Action	X (18)			4	3-4
Pollution		X (3)		2	3/4-1
Pollution Game		X (2)		1	½-3/4
Pollution-NCE		X (18)		12	1-1½

*Players' or team manuals provided.

ent rulings within the game's context during play. You need to keep in mind, however, that the more complex simulations necessitate more procedural guidelines which, in turn, may increase preparation time significantly. (Preparation time is the total time it takes the instructor and players to become familiar with the simulation model, procedures, and arrangements.)

Most of the simulations we evaluate here have instruction manuals that are adequate to give the facilitator a mental impression of the model and procedures on a cursory first reading. However, we became frustrated and impatient with the manuals for *No Dam Action* and *Dead River* because their formats interspersed procedure with background content information, making each more difficult to understand quickly.

Table 11 shows our ratings of the instruction manuals, the number of pages the manual devotes to procedure, and the approximate preparation times involved from the time the activity is removed from the shelf to the first operational move by players.

ACTIVITIES, SKILLS, AND INTERACTIONS

Are a simulation's activities, skills, and interactions consistent with your instructional objectives? Perhaps you are interested in having players participate in certain activities, reinforce or hone specific skills as they interact individually or in groups.

Table 12 lists patterns of generalized activities that occur in the sequence indicated (some are repetitive for a varying number of rounds) for each of the eight simulation games.

Table 13 indicates the kinds and degrees of specific skills and activities that participants practice in each of the simulations. This chart is organized using Bloom's Taxonomy as the vertical scale and the eight simulations as the horizontal. You should find this chart very useful in that the levels of skills displayed are hierarchical in ascending order, and each higher level necessarily incorporates those below it. The simplest skill, knowledge, involves information collection and processing; evaluation is the most complex.

Now that you are aware of the kinds of skills and activities represented in our eight simulation games, you will be interested in knowing to what extent they are practiced. Table 14

TABLE 12 Activity Sequences

Simulation Game	Activity Sequence
Dead River	1. Consensus on objectives 2. Determining share of costs 3. Analyzing cost/benefits 4. Presenting alternatives 5. Preparing a team proposal 6. Voting
Energy-Environment Game	1. Problem analysis by special interest groups 2. Public hearing #1 3. Task force meetings 4. Public hearing #2 5. Special interest group meeting
Energy-X	1. Fact finding and planning 2. Proposals/presentations 3. Project control decision making 4. Appeals
Gomston	1. Analysis and study of pollution sources 2. Team meetings 3. Town meetings 4. Decision making
No Dam Action	1. "Quest" activities 2. Intrateam analysis of background statements 3. Interteam analysis of resource reports 4. Establishing priorities 5. Decision making
Pollution	1. Developing pollution abatement programs 2. Analyzing results 3. Repeat cycle
Pollution Game	1. Determining ownership of properties 2. Adjusting water/air pollution indices 3. Adjusting taxation fees for properties 4. Elections 5. Repeat cycle
Pollution-Negotiating A Clean Environment	1. Intergroup negotiations 2. Voting 3. Analyzing consequences 4. Repeat cycle

TABLE 13 Specific Skills/Activities Represented (Ascending Order)

Skills/Activities	*Dead River*	*Energy-Environment Game*	*Energy-X*	*Gomston*	*No Dam Action*	*Pollution*	*Pollution Game*	*Pollution-NCE*
self-performance			s	s				
peer-performance			m					
proposals	s	vs	s	vs	vs			vs
6. Evaluation (exclusive of debriefing)								
planning strategies		s	vs	s	vs			s
planning goals		vs		s	vs			
writing/revising	s			s	s			
formulating models				m	vs			
making decisions	s	vs	vs	vs	vs	s	s	vs
5. Synthesis								
individual problem solving							m	
group problem solving	s	vs	vs	vs	vs	m		s
reviewing proposals	s	vs	vs	vs	vs			vs
4. Analysis								
voting on proposals	s	vs	s	vs	vs			vs
proselytizing	s	vs	vs	vs	vs			vs
negotiating	s	vs	vs	vs	vs	s		vs
challenging	s	vs	vs	vs	s			vs
role playing	s	vs	s	s	vs			vs
hypothesizing			s	vs	vs			
predicting		s	s		s	s	m	
inferring	s	s	vs	s	s	s	m	
3. Application								
large group discussion	s	vs	vs	vs	vs			s
small group discussion	s	vs	vs	vs	vs	m	m	vs
writing				s				
public speaking	m	s	s	s	s			vs
explaining			vs		vs	m		
interpreting data	s	vs	vs	s	vs		m	
2. Comprehension								
interviewing		s	m	m	s			s
reading/researching	s	s	vs	s	vs			m
recording data	vs				s			
observing	s		s	s		m	s	
collecting information	s	vs	vs	vs	vs			s
1. Knowledge								

Key: m—minor
s—significant
vs—very significant

gives our rating according to the variety of skills and activities used and the extent to which participants practice them.

If one of your goals is to provide a social environment in which participants develop communication skills through group work, you may find Table 15 helpful. It lists the kinds of social interactions each of the simulations exhibits.

RESOURCES AND SCORING

Additional concerns you will have in choosing an appropriate simulation relate to resources and scoring. For example, must the players keep track of money, chips, tokens, points, or some index throughout the simulation? Or, as in many environmental quality/energy simulations, are there no identifiable resources? What determines scoring? Do some players gain resources at the expense of others? Is the scoring procedure easily followed, or is it very involved? Table 16 summarizes resources and scoring for each of the eight simulations.

TABLE 14 Scope and Extent of Practice Skills/Activities

Extent Practiced	Number of skills/activities practiced: Few	Some	Many
High		*Pollution-Negotiating A Clean Environment*	*Energy-Environment Energy-X Gomston No Dam Action*
Moderate	*Pollution*		*Dead River*
Low		*Pollution Game*	

TABLE 15 Kinds of Interaction

Small Groups	Small & Large Groups
Pollution	*Energy-Environment Game*
Pollution Game	*Gomston*
	No Dam Action
	Dead River
	Pollution-NCE
	Energy-X

TABLE 16 Resources and Scoring

Simulation Game	Resources	Scoring
Dead River	No identifiable resources except influence differences among members of the Regional Council	Points allotted to teams according to various criteria on a Team Performance Score Sheet
Energy-Environment Game	No identifiable resources except influence differences on role profile cards	No explicit scoring procedure; Governor's Commission votes on proposals
Energy-X	No identifiable resources except influence differences among Region Representatives and Project Control officials	No explicit scoring procedure; Project votes on proposals
Gomston	No identifiable resources except influence differences among mayor, governmental officials and business/agency representatives	No explicit scoring procedure; win if problems are solved
No Dam Action	Influence points on role profiles are assigned to each participant and are unequally distributed	Two scoring methods suggested. 1. Ratings of involvement of groups/individuals by peer groups 2. Accounting of "risked" influence points
Pollution	Money and pollution tokens, equally distributed at start	According to amount of money earned, pollution indicators, and pollution tokens
Pollution Game	Money, election cards, and properties, equally distributed at start	According to amount of money accumulated and pollution levels
Pollution-NCE	Unequal distribution of influence	According to election results and associated Quality of Life and Personal/Corporate Goal Satisfaction scores

Kinds of Scoring Procedures

Table 17 indicates the kinds of scoring procedures the eight simulations use. Please bear in mind that in many energy/environmental quality simulations, it is unnecessary to have a scoring procedure. Usually, a class, group, team, or individual "scores" by proposing solutions to energy/environmental problems, by cooperating or competing with other groups or individuals, and, finally, by winning a vote of confidence for the solution proposed. Intrinsic student/group feedback is still provided at each step, and the effectiveness of individual or group performance becomes evident when proposals are either accepted or rejected. In many cases the entire class may "win" or "lose" according to the "quality of life" resulting from their interactions.

TABLE 17 Scoring Procedures

No explicit scoring; players vote on proposals	Individual Scoring	Group Scoring	Class Scoring
Energy-Environment Game *Energy-X* *Gomston**	*No Dam Action** *Pollution* *Pollution Game*	*Dead River* *No Dam Action** *Pollution-NCE**	*Gomston** *Pollution-NCE**

*Two kinds of scoring procedures overlap as indicated.

Evaluation of Scoring Procedures

We found that players had considerable difficulty learning the scoring procedures in *Polution–Negotiating a Clean Environment*, as evidenced by an excess of questions during play. This is easily understood, because the procedures involve more computation than a simple accounting of money or tokens. We would suggest either allotting more time to explain scoring for these simulations streamlining the scoring procedures according to your students' abilities.

In general, we observed that complicated and drawn-out scoring procedures tended to detract from the smooth flow of simulation sequences and that simulations with no explicit scoring procedures appeared to function more effectively.

MODEL VALIDITY

For each simulation you consider, you should ask yourself: "How closely does the simulation model approximate reality; that is, how valid (realistic) is this model?" By definition, educational simulations are simplified representations of reality. How much simplification are you willing to accept in exchange for ease of facilitation? Is what has been left out crucial to your instructional objectives? To what extent does a simulation's reliance on the random or chance factor distort the simulated process?

Table 18 gives our ratings of model validity based on discussion of the experience with our test instructors.

We are critical of the validities of *Pollution* and *The Pollution Game*, because of their excessive dependence on chance, although the latter compensates somewhat with "council

TABLE 18 Model Validity (Realism)*

Low	Adequate	High
Pollution *Pollution Game*	*Dead River*	*Energy-Environment Game* *Energy-X* *Gomston* *No Dam Action* *Pollution-NCE*

*Titles listed in descending order within columns

meetings" and "elections." In general, the most realistic and valid simulations are those that involve the interactions of diverse social and community groups in a problem-solving approach. In fact, the five listed in the "High" column of Table 18 were so realistic that we observed most players exhibiting high levels of frustration–frustration often observed in real-life situations.

For example, in the *Energy-Environment Game,* the Chairman of the Governor's Commission on Energy and the Environment reportedly walked out of the "chambers" because "there was no way we could satisfy everyone." In *Gomston,* where special interest groups are pitted sharply against environmental interests, the student playing the role of Gomston's mayor remarked, "We should wipe this mess off the map and start over somewhere else!" Many agreed.

DEBRIEFING

At the conclusion of the simulation sequence, it is important to provide an opportunity for players to discuss their feelings about the roles they played, the interactions within and among groups and between individuals, and the relevance, realism, and outcomes of the activity. This postsimulation discussion, often termed debriefing, should not be overlooked by the facilitator. It is an extremely important part of any simulation and is vital for closure.

Many simulation games provide a list of suggestions, guidelines, and/or questions that can help you adequately debrief the players. Some do not provide guidelines or questions, but may suggest the importance of debriefing, leaving it up to you to work out the details. A few ignore debriefing altogether. Obviously, in this case, you should take a few minutes of preparation time to draft a list of questions for debriefing.

Table 19 indicates our ratings of the eight simulations based on whether (and to what extent) they include provisions for debriefing.

TABLE 19 Provisions for Debriefing*

Totally Inadequate (No guidelines)	Inadequate (1-2 paragraphs)	Adequate (several paragraphs)	Thorough (1 or more pages)
Dead River	*Energy-X*	*No Dam Action*	*Energy-Environment Game*
Pollution Game	*Gomston***		
Pollution-NCE	*Pollution*		

*Titles in descending order within columns
**Provides several instruments for evaluation.

FLEXIBILITY

A high degree of flexibility in a simulation can be an important added attribute, because it will allow you a degree of ease in modifying format, procedures, roles, issues, rules, resources, and group size according to your objectives, needs, and interests. For example, a board game such as *The Pollution Game* is inflexible with respect to group size and roles because only from four to six players may physically gather around it. On the other hand, *The Energy-Environment Game* is so flexible that one could relatively easily provide for up to 64 participants because it includes an extra set of role profiles (two players using a pair of identical profiles). If an instructor preferred 64 separate roles, it would not be difficult to have students write another set.

In fact, those simulations that deal with group problem solving of local issues (for example, *Gomston* and *No Dam Action*) are the most flexible on nearly all counts. It is important to remember an earlier caveat, however: Less structure (more flexibility) requires greater maturity in participants.

Table 20 ranks each of the simulations for overall flexibility.

TABLE 20 Flexibility*

Inflexible	Some modifications possible	Flexible	Highly Flexible
Pollution Game	*Pollution*	*Dead River*	*Energy-Environment*
		Energy-X	*Gomston*
		Pollution-NCE	*No Dam Action*

*Titles in descending order within columns

MATERIALS AND COST

Final considerations in choosing any simulation relate to packaging, cost, expendable supplies (reusability), and completeness. If you have little time to spend on pregame preparation, you will want a simulation packaged as a complete kit that includes ample supplies of all the necessary materials, especially support components such as literature, score sheets, and maps. Because in many schools different teachers must share the same resource materials, you are probably seeking simulations that are durably packaged, inexpensive or at least reasonably priced, and have expendable copy that can be inexpensively mimeographed or xeroxed once the originals have been mutilated.

Table 21 summarizes cost and packaging information for each of the eight simulations.

We consider *Energy-Environment Game, Energy-X,* and *Gomston* to be the most reasonably priced kits for the money. They contain all the necessary materials, even including a filmstrip and audio tape cassette, as well as ample supplies of printed support materials. On the other hand, we believe *No Dam Action* and *Pollution* to be grossly overpriced, given the quality of materials and the packaging. *Pollution* arrives in an envelope with game pieces, manual, and a folding plastic game "board" more suitable as a table cloth. We found that after repeated handling the plastic smudged very easily.

We found that the 88-page manual for *Pollution–Negotiating a Clear Environment,* transparencies and pages in detachable binding, did not hold up well. The loose pages are easily misplaced.

CONCLUSION

Now, having considered well over a dozen criteria applied to the selection of energy/environmental quality simulation

games, you are faced with a decision: Which best meets your objectives, given preparation and playing time, group size requirements, and other limiting factors?

We offer one final table, Table 22, summarizing each simulation in terms of our ratings, which, in turn, were based on direct observation of each simulation game in operation. We used a five-point rating scale; an overall average rating appears in the last row of the table.

We consider the *Energy-Environment Game, Gomston, No Dam Action,* and *Energy-X* to be *excellent* simulations. *Dead River* is a *very good* simulation; *Pollution–Negotiating a Clean Environment* is *good*; and the remaining two are more or less *fair*. We award top honors in the energy category to the *Energy-Environment Game* and first prize for the best environmental quality simulation to *Gomston*. Both combine a knowledge of fundamental principles with a strong concern for the energy-environmental dilemmas confronting the United States, and both do so in ways that are highly motivational and fun—no small task. Above all, they teach in convincing fashion that there are no simple answers to complicated issues, that tradeoffs are inevitable, and that people, individually and collectively, still have a voice and a responsibility in determining future directions and goals for society.

Although we gave *Energy-X* and *No Dam Action* excellent ratings, we feel they are slightly less effective and less comprehensive than our first choices.

If you've been searching for your first "polluted river" simulation, we suggest that *Dead River* will serve your purposes well with its high validity, flexibility, and quality-to-cost ratio.

Pollution–Negotiating a Clean Environment, although exhibiting moderate to high degrees of model validity and flexibility, was deficient in the content and roles categories. Therefore, we rated it "good" on those items.

Pollution and *The Pollution Game* were relatively ineffective in their development and definition of roles, in simulating reality, in providing sufficient structural flexibility, and in maintaining high levels of participant interest. We rated them inadequate to fair.

Nevertheless, don't let our ratings dissuade you from a closer examination of those simulations that did not make high marks. The importance of various facets of each of the simulations we evaluated will differ with different purposes, objectives, and needs. You should select simulations according to your own requirements and the interests of your students. Remember, a small amount of your time spent in clarifying

TABLE 21 Packaging, Cost, Completeness and Reusability

Simulation Game	Packaging	Cost/Package	Completeness	Reusability
Dead River	kit	$13.00	complete	average
Energy-Environment	kit	1st edition was $20.00	requires some duplication (ditto)	high
Energy-X	kit	$19.95	requires some duplication (ditto)	high
Gomston	kit	$26.50	complete	high
No Dam Action	kit	$145.00	complete	high
Pollution	envelope	$26.00	complete	average
Pollution Game	kit	not set	complete	average
Pollution-NCE	manual with detachable binding	$27.00	complete	low

TABLE 22 Summary Ratings

Criterion	*Dead River*	*Energy-Environment Game*	*Energy-X*	*Gomston*	*No Dam Action*	*Pollution*	*Pollution Game*	*Pollution-NCE*
Content	3	4	5	3	4	2	1	2
Roles	3	5	3	4	5	1	1	3
Manuals	2	5	4	5	3	2	1	4
Skills	4	5	5	5	5	1	1	4
Validity	4	5	4	5	5	1	1	4
Flexibility	4	5	4	5	5	2	1	4
Debriefing	1	5	2	3	4	3	1	1
Completeness	5	4	4	5	5	5	5	5
Durability	3	4	4	5	5	3	3	1
Quality/Cost Ratio	5	5	4	5	1	1	3	4
Interest	4	5	5	5	3	2	1	3
Overall Rating (Average)	3.5	4.7	4.0	4.6	4.1	2.1	1.7	3.2

Key: 5—excellent
4—very good
3—good
2—fair
1—inadequate

your purposes and examining the pros and cons of each simulation may be well worth your effort in the long term, because, first, you are making an investment in a learning tool that will be used repeatedly by many students, and second, while a picture is worth a thousand words, a good simulation can be worth more than a thousand pictures!

Sources

Dead River
E. Nelson Swinerton
1973

Union Printing Company
17 West Washington Street
Athens, Ohio 45701
$13.00

Energy-Environment Game
Raymond A. Montgomery, Jr ,
and Toby H Levine
1973

Edison Electric Institute
90 Park Avenue
New York, N.Y. 10016
about $25.00?

Energy X
Norman S. Warns, Jr.
1974

Ideal School Supply Company
11000 South Lavergne
Oak Lawn, Illinois 60453
$19.95

Gomston
Norman S Warns, Jr.
1973

Ideal School Supply Company
11000 South Lavergne
Oak Lawn Illinois 60453
$26.50

No Dam Action
R G Kleitsch

System's Factors, Inc.
1940 Woodland Avenue
Duluth, MN 55803
$145.00

Pollution
Ron Faber and Judith Platt
1973

Games Central, Abt Publications
55 Wheeler Street
Cambridge, Mass. 02138
$26 00

Pollution Game
Educational Research Council
of America
1979

Carolina Biological Supply
2700 York Road
Burlington, NC 27215
price not established

Pollution: Negotiating a Clean Environment
Paul A. Twelker
1971

Simulation Systems
Box 46
BlackButte Ranch, OR 97759
$27.00