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ABSTRACT

The purpose of this publication is to provide science teachers with the means to enhance the learning of environment through the use of instructional games. Included are science and science-related games currently available commercially, from individuals or groups of teachers, and from private and public organizations and agencies. Over 100 entries are listed and indexed by content areas, grade levels by content areas, and topics and grade levels. Games are categorized by the following subject areas: biological science, physical science, earth/space science, and general science. Each entry includes the following information: title, grade level, purpose, playing time, number of players, price, developer, source, description, preparation and comments. (Author/RH)

games for the science classroom

an annotated bibliography

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INTRODUCTION

The purpose of this publication is to provide science teachers with the means to enhance the learning environment through the use of instructional games. Included are science and science-related games currently available commercially, from individuals or groups of teachers, and from private and public organizations and agencies. All the entries are indexed by content areas, grade levels by content areas, and topics and grade levels.

Games are categorized according to subject area: biological science, physical science, earth/space science, and general science. For each entry the following information is given: title, grade level, purpose, playing time, number of players, price, developer, source, description, preparation, and comments.

In researching the subject of games for this publication, the authors solicited entries from individuals and organizations across the nation, as well as examining the existing literature. The response to their requests was outstanding, totalling about 130 entries that met the criteria for inclusion. Submitted games were examined, analyzed, and played by the authors, and—whenever possible—used by classroom teachers with their classes. Although the authors verified the data given for each entry (grade-level, price, etc.), it should be noted that there may be exceptions. For example, the "grade level" designation varies greatly depending on the capability of any particular group; also, the publisher's information on grade level often covers a broad range (such as age 8–adult). The "number of players" may be misleading—frequently a team may play in place of one player, thus significantly increasing the number of participants. "Playing time" depends on the level of sophistication of the students, and on whether or not the group has played the game before. The "price" is always subject to change. "Source" can be either the original publisher or a distributor (both are given where available).* The addresses given for the sources were correct at publication; addresses may change over time.

*Editor's Note: In those instances in which an individual is listed as the "Source" for a game, please send a stamped, self-addressed envelope with your request to facilitate their response.

RATIONALE

There are many questions concerning the effectiveness of gaming as an instructional technique. Do games teach facts as well as other instructional techniques? Do educational games increase a student's decision-making and critical-thinking skills? Do games motivate students to learn? Do games increase the retention of knowledge by students? Are games able to modify a student's attitude? If games are as effective as (or even more effective than) other techniques, how does one explain this phenomenon? What advantages do games offer teachers as they develop their curriculum?

If the answers to these questions were readily available and positive, the rationale for utilizing games in the science curriculum would be apparent. In fact, though, they have not been answered by systematic research even though studies have been conducted with varying degrees of success. As with much social research, the conclusions drawn from many of the studies are in direct conflict with conclusions from other studies. This does not mean, however, that some benefit cannot be gained from the research or from discussing the value of simulation gaming as a science teaching strategy.

Numerous game theorists claim that simulation gaming can teach factual knowledge to include specific terms, concepts, facts, or relationships between items.[1] For example, certain science games may be designed to teach the names of lab equipment, the concept of food chains, the processes associated with science in general, or the relationships of the cell organelles with their functions. These experts feel that students learn factual information from games because of the immediate reward the students receive from using the information correctly during play. Thus students are motivated to learn the information so that it can be utilized correctly during play of the game to provide the player with some type of advantage. Games do provide students with opportunities to utilize the knowledge learned in an active manner.

Many theorists also maintain that students may increase their critical-thinking and decision-making skills during the play of certain types of games.[2] They assert that many games call for the careful scrutiny of several factors (critical-thinking) before a decision is made by a player

[1] Samuel A. Livingston and Clarice Stoll, *Simulation Games An Introduction for the Social Studies Teacher*. (New York, Free Press, 1973), p. 1.

[2] Sivasailam Thiagarajan, "Gamegame II", *Phi Delta Kappan*, 60 (March 1974), p. 474.

that affects his status in the game. Taylor and Walford state that certain games are designed so that "issues must be treated on their merits, alternative strategies must be devised and attempted, results observed, and conclusions drawn, on the basis of direct experience."[3]

Many game enthusiasts are quick to point out that players may make real-life decisions without suffering severe consequences. Thus gaming provides students with the opportunity to explore complex, real-life situations, critically analyze the information available, and formulate important decisions without fear of personal, lasting penalty.

Investigators have also looked into the question of knowledge retention as it relates to gaming. It would seem that the active utilization of factual knowledge would enhance the retention of that knowledge over a longer period of time but conclusions from research studies are inconsistent on this point. One might well expect students to retain a piece of information longer if they have had opportunities to recall the facts and utilize them in critical analysis or decision-making processes. The fact that a game might constantly require students to recall specific bits of information would lead one to suspect that they might be able to recall it readily at a later date. Basic learning theorists agree that retention is enhanced by the number of times an item is presented to a student. Many games are designed so that information is not only presented a number of times but utilized for certain knowledge skills. Obviously, more research needs to be designed and conducted to answer the question of recall and retention.

Heyman claims that simulation gaming is fun because of the active participation of students.[4] During simulation games students are actively involved in things such as role playing, team work, and decision making. Teachers are no longer the focus of the lesson for students are assuming a larger responsibility for learning. A healthy, competitive spirit can often be developed in the classroom that often leads students to important conclusions. Most actions have consequences for the individual and others associated with him and cooperation is often the key to solving many complex real-life situations. Winning is not associated simply with luck or chance but with sound decisions and judgments.

Since students are required to participate actively in the game utilizing knowledge to make real-life decisions, players may see a new relevance for the information. Often students are required to memorize facts for the sake of making a good grade on a test but a gaming situation may help students to relate information to everyday situa-

[3] William R. Heitzmann, *Educational Games and Simulations*, (Washington, D.C., National Education Association, 1974), p. 7.

[4] Mark Heyman, *Simulation Games for the Classroom*, (Bloomington, Indiana, The Phi Delta Kappa Educational Foundation, 1975), p. 11.

tions. Thus students should see the relevance of learning specific information.

Many research studies have found that students preferred simulation gaming to other teaching strategies for at least three important reasons: (1) students are active participants with games and not passive learners; (2) the role of the teacher changes from "source of knowledge" to "facilitator of knowledge," thus providing for a less threatening atmosphere for most students; (3) games help students to see the relevance of learning the information in the first place.[5]

Heitzmann, among others, thinks that games are also useful in the affective domain of learning as well as the cognitive domain.[6] He sites a series of research studies in which the conclusions support the hypothesis that games can change the attitudes of participants.[7] Heitzmann points out that certain researchers conclude that games are more effective at changing attitudes than any other teaching technique.[8]

Are there any logical reasons for games bringing about attitudinal changes in participants? Perhaps so. In many games individuals are placed in roles that are totally new to them. During the game participants interact with one another and they experience the thoughts, feelings, and actions of other players toward their roles. Often these interactions lead to new insights for all concerned.

Games: Flexibility for the Science Curriculum

Games are interdisciplinary in nature. Nearly all games require students to utilize skills from a number of the basic disciplines including English, social studies, and math—as well as science. In many games students must prepare convincing arguments, present these arguments in an effective manner, read outside sources to gain more specific information (often optional), read rules with understanding and clarity, and transfer information from one event to another in order to be successful. Students are often required to use computational skills in order to manipulate monies and keep up with the score. Many games require the social skills of persuasion, negotiation, resisting temptation or persuasion, and group cooperation. Most games give students the opportunity to deal with competition (either individual or group) in a social setting. Many processes of science are used in gaming and may include observing, classifying, inferring, interpreting data, questioning, and predicting. Obviously, a well designed game could require students to utilize basic skills from all of the major disciplines.

[5] Thiagarajan, *op. cit.*, p. 474.

[6] Heyman, *op. cit.*, p. 11.

[7] Harvard W. McLean, "Simulation Games: Tools for Environmental Education", *The Elementary School Journal* (April 1973), p. 370.

[8] John Taylor and Rex Walford, *Simulation in the Classroom*, (Baltimore, Penguin Books, Inc., 1972), p. 18.

Games are adaptable. Most games have an age range of several years but often rules may be modified or deleted to make a complex high-school game suitable for a junior high class. This type of modification may go either way—from easy to complex or from complex to easy.

Games are ideal for heterogeneous groups. The past few years have seen a shift in education from ability-grouped classes to heterogeneous classes and the emphasis on mainstreaming has brought about an instructional dilemma of major proportions for classroom teachers. Teachers, now more than ever before, must plan instructional activities that will meet the needs of students with wide ability ranges.

Games can be used as starting points for other activities. Many game researchers emphasize the importance of the post-game debriefing or discussion. During this part of the game the participants relate the strengths and weaknesses of the model presented in the game to the actual real-life situation. A game is at best a simplified model which includes enough information to make the activity useful and deletes enough information to make the game functional or playable. A discussion of the strengths and weaknesses of the model usually leads classes to additional insights and questions. From these discussions the more traditional activities such as research papers, discussions, debates, and lectures might arise.

USE

Once the decision is made to use games in the classroom, there are three important factors to be considered:

—How can games fit into the curriculum?
—What should one look for in selecting games?
—How does one use a game effectively?

In terms of the curriculum, games can be used to introduce a topic to the class, or as a means of summarizing a particular unit. Or, games may be used throughout a unit to facilitate student learning, to provide a change of pace, or simply for fun.

How to select games

The following checklist of questions is a basic inventory of items regarding the selection of any particular game for instructional use:

- Does the game help students learn something important?
- Is the game suitable for students in your class?
  - What is the reading level?
  - How much reading is involved?
  - How complex are the instructions? the procedures of play?
  - What skills are demanded in the game?
  - How difficult is score-keeping?
- How much space will be required to play the game?
  - Does it require special furniture or equipment?
  - Is it a noisy game? Will a special room be required?
- Are the roles clearly written and relatively easy to understand?
- How much time is required to play the game?
  - Is it possible to vary the time needed?
  - Can the game be divided to allow play on different days?
- Can the game be used over and over with the same group?
- Will the game last indefinitely?
- How complicated are the mechanical aspects of the game? How many pieces are included?

Preparing to use games

The key to successful game activity may well be the skill of the teacher not only in selecting the appropriate game but in administering and organizing the activity. Here are some practical guidelines in preparing to use an instructional game:

- You should thoroughly understand the game, how it works, and what is expected of each player. (The best way to learn this is to play the game.)
- Be sure all of the game components are present. If materials must be counted out for each player, you may want to do this ahead of time.
- Decide how you will present the game to the students.
  Explain goals and objectives.
  You may want to distribute written instructions.
- Spell out the ground rules for playing the game:
  What is an appropriate noise level?
  What are the physical boundaries for game activity?
  Who may be consulted for advice and/or information?
  Who will be the referee?
  What are the time limits?

Some games presuppose a certain level of knowledge or experience to successfully play the game. In this case, teachers need to prepare students with the necessary background information. For nearly all games, some preliminary discussion is in order.

In order to benefit most from game use, follow-up discussion is highly recommended. Talk about the game itself—strategies, results, and ideas for play "the next time around." Then let students generalize from their experiences in the game to their own "real life" situations.

Games are exciting techniques that can lead to beneficial results in the classroom. But like any effective technique, they do not "just happen." The teacher is the key in the decision to use games, and then in their selection, use, and evaluation.

A final word of advice is perhaps as important as any mentioned above: attitude of the students. Students must be in the right "frame of mind" to benefit from any game but particularly simulation games. Usually the atmosphere is determined and set by the teacher so prior thought needs to go into "mood setting" introductions and explanations.

EVALUATION

Evaluation that will benefit you, your students, and your instructional program involves two aspects: the learning objectives and the actual games. The first consideration is whether or not the game satisfies the learning objectives set forth for its use. Do students learn what you wanted them to learn—the periodic table? the parts and functions of the body? how to solve environmental problems? As with any objective, you may determine its achievement in a variety of ways. These authors recommend only a subjective type of evaluation for games used in the classroom.

The second aspect involves the games themselves, and includes factors mentioned in the discussion on the selection of games. (Is the game mechanism strategically sound? Is the game suitable for your students? Is there a teacher's manual?) In addition, opinions from you and your students—whether written or discussed in class—are important.

- How do your students feel about the games?
- Do they feel they have learned something through playing the game?
- Did they enjoy playing the game?
- Would they like to play it again? outside of school?
- What are its strengths and weaknesses?
- How could its use with classes be improved?

The literature on game use strongly recommends that grades *not* be used to evaluate a student's participation in a game. Too many factors beyond the control of the player affect overall play to make grade evaluation possible or advisable. It is possible, however, to assess gain of knowledge, skills, and attitudes in the various areas covered by games in much the same manner as you assess these factors in routine classroom operation.

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INDICES

INDEX BY CONTENT AREAS
(with grade levels)

Biological

INDEX BY GRADE LEVELS AND CONTENT AREAS

Kindergarten–Grade 3

Biological

Earth–Space

General

Grades 4–6

Biological

Grades 7–9

Biological

Physical

INDEX BY TOPICS
(with grade levels)

Advertising

Animals

Anthropology

Atoms

BIOLOGICAL SCIENCE GAMES

TITLE: **BALANCE**

GRADE LEVELS: 10th–12th

PURPOSE: To develop an awareness of the conflict between the economic-social values necessary for a family to function and ecological values necessary for our physical environment to survive. According to the authors, students who participate in this simulation will possess the following: knowledge of the extent of the current ecological crisis, appreciation of the difficulties facing families wanting to do something to alleviate the crisis, and skills in researching materials and interviewing adults about this crisis.

PLAYING TIME: 3 weeks (15 one-hour sessions)

NUMBER OF PLAYERS: 25 to 35

PRICE: $12.00

DEVELOPER: David Yount and Paul Dekock

ORDER FROM: Interact, P. O. Box 262, Lakeside, California 92040

DESCRIPTION: **BALANCE** consists of a game booklet with descriptions of all roles in the game, general objectives of the game, a three-week sequence chart, descriptions of the major issues, rules for playing the game, and an essay evaluation instrument as well as an attitude survey.

BALANCE is a simulation of four families that live in the imaginary town of Ecopolis. Each family faces a major ecological dilemma: air pollution, water and power, land use, and population. Each student plays a member of each family during the game and the issues are considered during the role-play. A "Family Decision Form" is filled out after each group plays a particular family. Decisions are made from the facts presented during the role-play and students are awarded points at the end for their decisions. An essay evaluation concerning the four dilemmas is given at the end of the game.

PREPARATION: Teachers are encouraged to turn their classrooms into environmental learning centers during the game. This is accomplished by putting up interesting bulletin boards, developing resource areas on each dilemma, and working with librarians to supply added resources.

The game is complete; however, many sheets must be copied to hand out to the students and name tags must be made. A bulletin

board representing the city of Ecopolis is also recommended for the room.

COMMENTS: **BALANCE** is an excellent way to learn about the conflicts of our economic desires with our environmental concerns. The game's success depends upon the resourcefulness of its players. If students are lacking in library skills, serious consideration should be given to developing these prior to the game. A teacher might also consider giving a more structured bibliography of articles to the slower students as they consider each ecological crisis. This is a well developed game that seems to teach its proposed objectives.

The authors have a three-week sequence planned for the game. This time span may be shortened or lengthened. Two weeks would seem to be the minimum for completing the entire game, with the recommended three weeks being ideal. Additional dilemmas and roles may be added to the game which would lengthen the game considerably.

TITLE: **BIO-E-Z**

GRADE LEVELS: 7th–10th

PURPOSE: To teach the student certain fundamental facts and principles dealing with life processes, plants, animals, genetics, evolution, and ecology.

PLAYING TIME: 50 minutes or less

NUMBER OF PLAYERS: 2 to 6

PRICE: $5.00 or 5 copies for $15.00

DEVELOPER: John H. Woodburn

ORDER FROM: E-Z-Science Games, 9208 LeVelle Drive, Washington, D. C. 20015

DESCRIPTION: The game includes a paper game board suitable for mounting on heavy cardboard, name markers, "owners" markers, dice, and six decks of question cards. There is a deck of question cards for each of the following biological areas: plants; animals, genetics, evolution and ecology, and application of biological principles.

The game is played by students rolling the dice and moving their markers the number indicated. Each player takes a question card from the pile and another player reads the question aloud. If the first player answers the question correctly, he scores the number of points indicated on the square. He also places one of his "space ownership" markers on the space to indicate ownership. If the player fails to answer the question, the correct answer is read and no points are lost or gained. Players return question cards to the bottom of the pile. When a player lands on a space that is owned by another player and fails to answer the question, the owner scores the points indicated on the square. However, if the "visitor" answers the question correctly, he wins the points. The corner spaces are squares that cause the players to either gain or lose the number of points indicated without answering any questions. The player with the highest number of points at the end of a designated time is declared the winner.

PREPARATION: The author suggests that the teacher cement, glue, or tape the playing board to a piece of heavy cardboard before play begins. The tetrahedron-shaped name markers and ownership markers also have to be cut out and put together.

COMMENTS: The game seems to be an excellent way of reviewing certain biological principles and facts. The author suggests that additional question cards may be designed so as to review additional facts. A teacher may also want to adapt a special set of question cards for slower students.

The game has two important design factors that help to insure active involvement of all participants at all times. First, another player must read the question to the player who has moved his marker. This helps to insure that all persons will listen to the questions as they are being read and as they formulate their own answers. Secondly, by owning the squares a player is motivated to keep track of other students' answers because incorrect answers can mean points to the player owning the square.

The time in this game is flexible. A teacher may call time at any point along the way. The author suggests 50 minutes or less for playing BIO-E-Z.

TITLE: **THE BLOOMING GAME**

GRADE LEVELS: 4th–6th

PURPOSE: To teach the students the similarities of a group of flowers.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 2

PRICE: unknown

DEVELOPER: American Association for the Advancement of Science

ORDER FROM: Science—A Process Approach II (Module 91), Ginn and Company, 191 Spring Street, Lexington, Massachusetts 02173

DESCRIPTION: **THE BLOOMING GAME** consists of a deck of twenty cards. Each card has a picture of a familiar flower.

The game is played by shuffling the cards and dealing each player five cards. The rest of the cards are stacked face down. The top card on the deck is turned face up.

The first player takes a card from his hand that has a characteristic similar to the top card on the deck. The characteristic may be the same number of petals, the same shape, the leaves that look the same, etc. The player then tells how his card is similar to the top card and places his card face up on the deck. The next player selects one of his cards and places this on the last card played. This player tells how the flower on his card is like the one on the pile and cannot use the same similarity as the previous player. When a player does not have a card that can be played, he must draw a card from the face down pile.

The game ends when all cards have been drawn or when a player has played all of his cards. A player is given one point for each card left in his hand. The first one to reach a score of 25 loses.

PREPARATION: An introduction to plant characteristics may be appropriate before this game is played.

The cards come in a sheet and must be cut apart before play is started.

COMMENTS: The game seems to accomplish the objective of getting students to recognize similar characteristics of a group of plants and this is one of the preliminary skills that a student must possess before being able to classify objects.

This game is flexible with relation to playing time. A game may be considered to be one hand, the best four out of seven hands, or the first one to reach 25 points. This flexibility insures that the game may be played with varying time requirements.

TITLE: CAMP-A-RAMA

GRADE LEVELS: 3rd–6th

PURPOSE: To help youngsters learn more about camping and how to handle unforseeable situations as they arise.

PLAYING TIME: 30 to 40 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: ERIC charge

DEVELOPER: Pennsylvania State Department of Education

ORDER FROM: ED 081 595, ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1200 Chambers Road, Third Floor, Columbus, Ohio 43210

DESCRIPTION: Materials are not provided with the game but very precise directions are given for the collection and construction of game components. Materials needed include two 22 × 28″ sheets of poster paper, 3 felt tip markers, masking tape, glue, approximately 75 index cards, six "pace" markers ("men"), and a cube or die.

To prepare to play, the poster paper must be taped together so that the various "trails" with caves and other "natural" characteristics may be drawn and painted. Next, six sets of 18 cards per set should be prepared with each card having the name of an item of camping gear or camping supplies plus a picture of the item, if possible. "Hazard" cards and "Campsite Event" cards must also be prepared, as per instructions, and will require 30 or so cards.

To play, each player receives a set of cards from which six camping items are selected; these are the things he will take on the camping trip. Each player chooses one of the paths available and, in turn, each rolls the cube to see how many spaces should be moved. As campers continue down the paths, they undergo whatever is required by "Hazard" cards or other game stipulations and when they reach the "campsite," they work with the campsite events.

The player with the highest accumulated point total wins the game.

PREPARATION: No particular preparation is required by players other than the usual discussions to get a game underway. Preparation time is necessary to get materials ready to play the first time, as mentioned earlier.

COMMENTS: This is an interesting game that students will enjoy and learn something about camping, hiking, and getting along with others.

TITLE: CELL CHALLENGE

GRADE LEVELS: 7th–10th

PURPOSE: To enable the student to match the parts of generalized plant and animal cells with their respective functions.

PLAYING TIME: 50 minutes

NUMBER OF PLAYERS: 2, 4, 6, or 8

PRICE: $7.50

DEVELOPER: not listed

ORDER FROM: The Fun Time Company, 1374 Glenrock Drive, Maryland Heights, Missouri 63043

DESCRIPTION: The game consists of a game board and a deck of 129 cards. The board has an illustration of both a generalized plant and animal cell. Seven specific organelles of each cell are enlarged around the outer edge of the playing board. These enlargements match the illustrations on the playing cards.

The playing deck has 12 each of the plant and animal cell cards, 3 each of the delay cards, 6 each of the remedy cards, and 3 each of the cell information and cell parts cards.

The object of the game is to be the first team to complete their cell. Completing a cell is accomplished by playing the information card for each of the 7 organelles and their corresponding cell part cards. Cell information cards and cell parts cards may be played by a team as long as their plant or animal cell cards are showing. An opposing team may block another team's play by placing a delay card on the cell cards. "No Sunlight" and "No Carbon Dioxide" may be played to delay the plant cell team while the "No Oxygen" and "No Food" delay cards may be played to delay the animal cell team. If a delay card has been played on a team, the team must play a remedy card (i.e., "Food" or "Carbon Dioxide") and another plant or animal cell card before laying down a cell information or cell parts card. The first team to lay down all 7 information cards and 7 cell parts cards is the winner.

PREPARATION: All the parts for playing this game are included in the game package. It may be used to introduce a generalized plant and animal cell or as a review of the parts and functions of these cells. The game may be used with students who have not had an introduction to the cell because the information needed to play the game is found on the game board and cell information cards.

COMMENTS: This game should accomplish three important cognitive objectives concerning plant and animal cells. First, the students should be able to name the parts of the generalized plant and animal cell. Secondly, the players should be able to give the functions of each of the cell parts. These functions are described as "key-words" in the game. For example, the function associated with the mitochondria is "power." A third objective focuses on the differences between specific organelles found in plant and animal cells. Students can visually see the key differences. In addition, the game emphasizes the environmental needs of both plant and animal cells. Because the game has a competitive format, that emphasizes team work, students are actively involved and thinking at all times during the game. This helps to insure that students are using and learning the information about plant and animal cells.

As teams become more proficient in the rules and information needed to play the game, the game's pace will quicken. In some instances the players will be able to complete the game more than once in a 50-minute period.

TITLE: **THE CELL GAME**

GRADE LEVELS: 10th

PURPOSE: To teach students the basic structure and functions of living plant and animal cells.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 2 to 4

PRICE: $2.95

DEVELOPER: not listed

ORDER FROM: Tecolote Press, Inc., P. O. Box 217, Glenwood, New Mexico 88039

DESCRIPTION: The game consists of the following components: a gameboard, a spinner, and punch-out parts representing the various cell organelles.

The object of **THE CELL GAME** is for a player to be the first to complete his cell. Players complete their cells by moving around the gameboard and following the instructions on the space landed upon. In a complete cell, all the blank spaces in the cytoplasm will be filled and there will be a chromosome in the nucleus.

During the game the following concepts are also introduced: diffusion, active transport, pH, and synthesis. Students must understand these concepts in order to follow certain instructions. The first player to complete his cell or the player with the most points at the end of a specified time is declared the winner.

PREPARATION: All materials for playing this game are included in the game kit. Instructions are clearly written. However, if the concepts of diffusion and active transport have not been introduced, some time must be taken to discuss these concepts.

COMMENTS: This game does more than familiarize students with the cell organelles. It utilizes the concepts of diffusion, active transport, pH, and synthesis. In order for a student to be able to play this game, he must be able to tell which direction materials would move in a specific instance if diffusion or active transport took place. The students would also need to know the ideal pH for the cell's environment and which materials make up the genes, fats, sugars, and proteins.

One of the most important aspects of this game is that it shows the cell to be an active unit of organization. During the game materials are actively transported, diffused, and synthesized.

TITLE: CIRCULATION

GRADE LEVELS: 7th–12th

PURPOSE: To provide opportunities for students to "participate" in the operation of the human circulatory system.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 2 to 4

PRICE: $12.95 plus $1.50 handling

DEVELOPER: Robert Grossman

ORDER FROM: Teaching Concepts, Inc., 230 Park Avenue, New York, New York 10017

DESCRIPTION: Materials provided include a large game board with "spaces" marked on an outline of the circulatory system of the human body. The spaces "flow" from and into the heart from the arms, legs, and head and may pass through the stomach, kidneys, and lungs. Other materials are plastic trays (4), score cards (shaped like the human body), a number of small colored discs to represent food, oxygen, gaseous waste, renal waste or white blood cells, "emergency" and "circulate" cards, and a spinner.

To play the game, participants move "plasma trays" (representing blood plasma) through the arteries and veins of the human body. The object of the game is to supply the arms, head, and legs with food and oxygen. Players must pick up food in the digestive system and oxygen in the lungs and transport them in plasma trays to the capillaries of the arms, legs, and head when they are exchanged for waste squares (gaseous and renal). Players must dispose of the waste products as well as ward off "germ attacks" and control "emergency" situations. The first player to supply the arms, legs, and head with food and oxygen is the winner of the game.

PREPARATION: Minimal time is required to set up and prepare all materials for play. Some time should be allowed for discussion of rules and procedures and to explain the game components; however, after playing one time this will not be necessary.

The game does provide opportunities for discussing the human circulatory system, its function, and operation. The heart and its parts, arteries, veins, lungs, kidneys, oxygen, wastes—these and other topics could be discussed prior to and/or following use of the game.

COMMENTS: The game is somewhat difficult to understand at first. Playing is the best way to truly understand and students may need encouragement to continue long enough to find that the game is a challenge. The teacher or at least one student should play the game prior to use in the classroom.

Repeated playing will develop skill in game decision making and time required will decrease; the more players or teams involved, the longer it will take.

TITLE: IIS CLASSIFICATION CARDS

GRADE LEVELS: 7th–10th

PURPOSE: To group a set of animal cards according to related characteristics.

PLAYING TIME: 1 class period or less

NUMBER OF PLAYERS: individuals or small groups

PRICE: contact publisher

DEVELOPER: Harry Wong and Marvin Dolmatz

ORDER FROM: Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

DESCRIPTION: Each deck of 60 classification cards has four sets of fifteen different animals. Each card has a picture of the animal, the name of the animal, and some information about the animal (external covering, appendages, teeth, heart, and respiratory mechanism).

A player sorts the cards into stacks according to a specific characteristic. However, not only does each card in each stack have to be related but each stack's characteristic must be related to the other stack's characteristic. For instance, you would not want to separate the cards into stacks of swimmers, flyers, and animals gray in color. Instead, an acceptable grouping of cards might include a stack for each of the following: animals with feathers, animals with hair, animals with scales, and animals with skin. Each of the above stacks are grouped according to the organisms' outside covering.

The object of this exercise is to see how many different ways a player can group the animals.

PREPARATION: All the materials for doing this exercise are included in the deck. The rules for playing this game are found in **IDEAS AND INVESTIGATIONS IN SCIENCE—BIOLOGY** by Harry Wong and Marvin Dolmatz.

COMMENTS: This game may be considered by some teachers as a classification exercise. Students may or may not compete against each other.

A specific time limit should be set for each session. If the time is longer than 15 to 20 minutes, students may tire of the game.

Prentice-Hall does recommend that this game be used in conjunction with the IIS program.

TITLE: CLEAN-UP

GRADE LEVELS: K–4th

PURPOSE: To help the student realize the importance of keeping their cities and towns clean and attractive and that everyone must help to remove trash and garbage and replace them with trees and shrubs, flowers and grass.

PLAYING TIME: 30 to 60 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $5.00

DEVELOPER: not listed

ORDER FROM: Damon/Education Division, 80 Wilson Way, Westwood, Massachusetts 02090

DESCRIPTION: With straws and "joiners," students form six city "blocks" and then place six block markers (pictures) within the city to designate a shopping plaza, a playground, a park, a school, a baseball park, and a home. Other game equipment includes Trash Cards (24), Beauty Cards (24), and a spinner. Four trash cards are placed in each city block and each player gets an equal share of the Beauty Cards. The spinner pictures each of the six town blocks and on each "spin" the pointer lands on one of the blocks.

Two to six players can play the game as follows: after each spin, to locate their designation within the city, the student begins at "home" and must hop on one foot to the destination. At the destination the player picks up one Trash Card and deposits one Beauty Card—green grass, flowers, trees, or a closed trash can. The first player to use all of the Beauty Cards wins.

PREPARATION: Actual time to prepare materials is minimal, perhaps 5 minutes to construct the city and distribute the cards.

The teacher will want to conduct some pre-game activity and post-game discussion to get maximum benefit from the game: "How do you clean up a city or town?" "How do you beautify?"

COMMENTS: A useful game to focus on trash pollution, what to do about trash in the city, and beautification projects.

Time will vary with the age of the children, the number of children playing, and the extent of pre-game and follow-up discussion. Six first graders should be able to play one complete game in 30 minutes or less.

TITLE: COLORADO: PROBLEMS AND PROMISES

GRADE LEVELS: 7th–12th

PURPOSE: To stimulate fruitful interaction and informed debate of the environmental issues confronting Colorado, while creating an awareness of the compromises and trade-offs that will ultimately result.

PLAYING TIME: 7 to 10 class periods of 45 to 50 minutes

NUMBER OF PLAYERS: 7 to 35

PRICE: free loan

DEVELOPER: Charles A. Bottinelli

ORDER FROM: Public Service Company of Colorado, 550 Fifteenth Street, Denver, Colorado 80201, Attention: Publications Department

DESCRIPTION: The game includes the following items: a gameboard, senator profile cards, name plates, name tags, committee assignment sheets, maps of senatorial districts, senate rosters, "bills" passed by house, issue cards, teacher's guide, ditto master, and transparencies.

The game revolves around 25 environmental bills that are of a controversial nature. Each senator is placed on one of five "Senate Reference Committees." Each committee researches all aspects of the bills assigned to it, amends them, and acts on them.

Bills that pass the various committees are presented to and acted on by the full senate. Senators vote under extreme political pressures of their constituencies because of the controversial nature of each bill. The bills that pass the full senate are sent to the Governor for his signature or veto. Possible veto overrides may be considered for specific bills. Finally, re-elections are held for one-half of the senate.

PREPARATION: The teacher is responsible for running dittos of the committee ballots and the various senate bills. It may also be appropriate for teachers to work with the librarian to insure that reference materials are available. The author also suggests that the role of Governor be played by a local official or parent. If this suggestion is followed, the teacher must secure the services of an additional individual. The room should be arranged to look like a senate hearing room.

COMMENTS: This simulation game is a well-planned series of educational activities. It utilizes the skills of debate, library research, and open discussion during its play. The issues incorporated into the various "bills" are ones that have top priority in today's legislatures. Popula-

tion, recycling, predator control, environmental education, aerosol can ban, energy resources and conservation, and insecticide ban are among those issues that are researched, argued, and voted upon.

The game is especially effective in its ability to have the student research the present-day issues and develop sound decisions based upon the facts. The teacher is utilized as a facilitator and summarizer. The author suggests that the teacher act as a reporter that summarizes the major happenings of the previous day and reports these to the class at the beginning of each session.

The game includes a time schedule of ten 50-minute periods. This schedule may be revised to meet the individual needs of the class.

TITLE: CONCENTRATION WILDLIFE EDITION

GRADE LEVELS: 3rd–8th

PURPOSE: To provide opportunities for students to become familiar with and know more about animals and plants of the wildlife community.

PLAYING TIME: 15 to 30 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: $1.25

DEVELOPER: not listed

ORDER FROM: National Wildlife Federation, 1412 Sixteenth Street, N. W., Washington, D. C. 20036

DESCRIPTION: Game materials consist of a deck of 40 cards each with a wildlife subject plus instructions for playing the game and "Information and Educational Notes" about each of the wildlife subjects.

To play, each card is placed face down on a table not touching any other card. In turn, each player turns over 2 cards so that all may see. If a pair of like cards is turned over, the player removes them and has another turn. If the pair turned over is not a match, they are turned back over, face down, and other players are then able to select them or others as the next pair.

The winner is the player who has the most pairs when all of the cards have been picked up.

PREPARATION: No preparation is required to play the game but the teacher could have a number of discussions (in a variety of ways) about the wildlife subjects on the cards.

COMMENTS: The 40 cards have 20 beautiful wildlife subjects painted by outstanding wildlife artists and, in addition, game materials include information on each animal in the deck. In addition to being a game that is challenging to students, the animals provide "material" for classroom activity—discussions, individual or small group study and project work, classroom visitation, and the like.

Playing time would be 15 to 30 minutes for each "round" but students could play a number of rounds.

TITLE: CONSERV-O

GRADE LEVELS: 4th–6th

PURPOSE: To expose students to conservation problems and practices in the United States.

PLAYING TIME: 30 to 50 minutes

NUMBER OF PLAYERS: 30 to 35

PRICE: ERIC charge

DEVELOPER: Pennsylvania State Department of Education

ORDER FROM: ED 081 595, ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1200 Chambers Road, Third Floor, Columbus, Ohio 43210

DESCRIPTION: Game materials require a game board, Conservation Problem Cards, Department Cards, Department Visit Cards, Wild Cards, and one die. Instructions for constructing the game board and all the cards for playing the game are provided.

The game board consists of a map of the United States, divided into eight geographical regions. Each region has a "trail" of six moves running throughout. The Conservation Problem Cards (48) are made from 3 × 5 index cards and each has printed a problem for one of the 8 regions. The Department Cards (6) have printed the functions of one of the 6 departments (i.e., Department of Mines and Minerals and Department of Health). The Department Visit Cards are made from the 26 functions stated on the Department Cards, and the Wild Cards are statements of "things that could happen" as one travels throughout the nation (i.e., "no bathing on oil slick beach for you"—go ahead 4 spaces).

Play proceeds with the roll of the die. Players answer questions and move their markers from Florida across country to the West Coast, then to Maine. The first player to reach Maine wins the game.

PREPARATION: Teachers may need to discuss with students the object of the game, the governmental departments used in the game and their functions, and the various regions of the nation and some of the kinds of conservation practices that could go on there.

COMMENTS: This is an interesting and exciting game for students who are involved in the study of conservation practices. The game is well thought-out and planned.

The teacher (or leader) will need to spend some time getting all materials ready for play.

TITLE: THE DEAD RIVER

GRADE LEVELS: 7th–12th

PURPOSE: To give students a vicarious experience in making decisions which affect the economic, social, and physical well-being of a region relating to the quality of the water in that region.

PLAYING TIME: 5 (50-minute) sessions or 4 hours

NUMBER OF PLAYERS: 10 to 32

PRICE: $9.00 or 5 copies for $40.00 $12.00 (Damon)

DEVELOPER: E. Nelson Swinerton

ORDER FROM: Union Printing Company, Inc., 17 West Washington Street, Athens, Ohio 45701; Damon/Educational Division, 80 Wilson Way, Westwood, Massachusetts 02090

DESCRIPTION: The game includes the following materials: an instructor's guide, five team guides, and five team identification plates.

The class is divided into five teams to begin play. The teams include the following: Taxpayers Association, Valley Recreational Development Association, Regional Industry, State Eco-Action Agency, and Federal Enviro-Policy Agency. Each team works through the exercises found in the team guide. The team prepares a position for cleaning up The Dead River and a defense of that position to be presented to the Regional Council. The Regional Council meets and decides upon an appropriate course of action. Each team then completes a team performance sheet to determine how well it performed during the exercise.

PREPARATION: All materials for playing this game are included in the game kit. The major preparation for playing this simulation involves the physical arrangement of the classroom. Five separate meeting places, one for each team, should be set up in the room. When the teams move to the Regional Council, six tables should be arranged in a rectangle. These physical arrangements should be made before the students arrive.

COMMENTS: The most important aspect of this simulation is its organization. Each team is given a booklet containing exercises that will help the students formulate their positions. The exercises also help provide input from a wide number of sources. This could possibly broaden each team's considerations when developing their positions.

The simulation also provides a means for all the teams to present their individual positions to the entire class (Regional Council). This would seem to provide students with the opportunity to see that positions other than their own could be rationalized using another group's interests. This is an important aspect of making decisions in a democratic society.

Normally, the game can be played in four hours, probably best organized into five class periods of 50 minutes each. This amount of time should provide an opportunity for the introduction of the game, the actual playing of the simulation, and a discussion of what took place during the game experience.

TITLE: DIG

GRADE LEVELS: 10th–12th

PURPOSE: To provide opportunities for students to learn more about archeological techniques and culture examination, become involved in discussions, and formulate interpretations from archeological evidence.

PLAYING TIME: 20 hours (recommend 1 hour per day for 4 weeks)

NUMBER OF PLAYERS: up to 35

PRICE: $12.00

DEVELOPER: Jerry Lipetzky

ORDER FROM: Interact, Box 262, Lakeside, California 92040

DESCRIPTION: Materials provided are found in a very complete booklet which describes the simulation **DIG**, gives the purposes and objectives, an overview of activity week-by-week, specific instructions for the entire simulation, directions on how to make the necessary materials and 17 pages of forms to be xeroxed.

In the first week (Phase I), the class is divided into two equal size (and skill) teams which begin immediately to create a culture, deciding on the time, value and ethics, and choosing the culture universals. Phase II consists of turning the ideas of Phase I into artifacts that accurately reflect the elements of the culture they are creating. They also receive instructions in the techniques of an archeological excavation. Phase III finds the class in the field excavating 6-foot square pits that have been "seeded" with artifacts by the other group. In Phase IV the teams reconstruct and analyze the "strange" cultures they have unearthed.

PREPARATION: Preparation for this simulation is actually part of the activity. For example, there must be library research but this is required as the game proceeds, not "in preparation."

There are a number of forms and charts that must be duplicated but the copies in the booklet can easily be xeroxed or machine copied by other processes.

COMMENTS: A well conceived and well structured simulation for getting across a feeling for and understanding of ancient cultures and the archeological challenges associated with ferreting out details about that culture. It does take time and short cuts will destroy the effective-

ness. As with most simulations, the teacher must create the proper setting for this one to succeed and must continue to maintain this setting for the entire time. Students are expected to assume considerable responsibility and must work very hard to bring about successfully all aspects of simulation activity.

TITLE: DISASTER

GRADE LEVELS: 5th–6th

PURPOSE: To understand better some of the problems of pollution and population.

PLAYING TIME: 30 to 45 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: free

DEVELOPER: Bonnie Barr

ORDER FROM: Description from *Science and Children*, Volume 8, Number 3, (November) 1970, p. 24–25.

DESCRIPTION: Materials that must be obtained include 4 pieces of pegboard, colored pegs, playing discs, a pair of dice, and a playing board.

Each player has 10 "air" pieces, 10 "food" pieces, 10 "water" pieces, and one "people" piece with its allotment of air, food, and water. The playing board has a rectangular playing track with 20 spaces. Each space requires the player to take some action for a natural disaster (flood, hurricanes, or earthquake) requiring an expenditure of air, food, or water.

Each player begins at "start" and rolls the dice to determine the number of spaces to move. Upon landing the player must respond as instructed.

The player who stays in the game the longest is the winner.

PREPARATION: All materials must be collected and prepared for use and, in addition, the gameboard must be designed and constructed. While time and effort will be necessary to get ready to play, the teacher could well direct student interest and effort in helping to prepare the necessary materials.

COMMENTS: From the *Science and Children* article titled "Disaster is the Name of the Game," the game appears well designed and likely to bring about greater understanding "of some of the problems of pollution and population."

TITLE: **ECOLOGY**

GRADE LEVELS: 4th–12th

PURPOSE: To acquaint students with the economic and environmental challenges of three ages of civilization—Hunting, Agricultural, and Industrial.

PLAYING TIME: 1 to 2 hours

NUMBER OF PLAYERS: 2 to 4

PRICE: $7.00

DEVELOPER: not listed

ORDER FROM: Damon/Educational Division, 80 Wilson Way, Westwood, Massachusetts 02090

DESCRIPTION: The game includes the following materials: a gameboard, rule book, Luck cards, Work cards, Genius cards, Ecology Point cards, chips, dice, and money.

ECOLOGY puts each player in charge of leading a population through three challenging ages of civilization—Hunting, Agricultural, and Industrial. Each player's goal is to survive the conflict between technology and nature and reach the ideal Environmental Age. If a player is successful at building an ecological balance, his people live on and he wins **ECOLOGY.**

PREPARATION: All materials for playing **ECOLOGY** are included in the game kit. The directions are clearly written and easily understood. The game itself will take a few minutes to comprehend fully because of the nature of the complex problems.

COMMENTS: The most important aspect of this game is a historical one. After students have finished playing this game, they should be able to comprehend the differences in impact of certain economic and environmental practices through the various ages of civilization. The players are challenged to provide a balanced environment while creating inventions and earning money. Thus, the players must find ways to resolve the conflict between technology and nature. The winner of the game must have a certain amount of money, a specific number of ecology points, a certain number of inventions, and a specific population.

TITLE: **ECOLOGY GAME**

GRADE LEVELS: 7th–9th

PURPOSE: To provide opportunities for students to utilize a variety of information about the environment while competing against one another for points.

PLAYING TIME: 30 to 45 minutes

NUMBER OF PLAYERS: 4 to 6

PRICE: free

DEVELOPER: Project R-3

ORDER FROM: Project R-3, Herbert Hoover Junior High School, San Jose Unified School District, 1450 Naglee Avenue, San Jose, California 95126

DESCRIPTION: The **ECOLOGY GAME** consists of the following components: a lightweight gameboard, four decks of question cards (one each on soil, water, air, and plant life), one die, six markers, two scoresheets, a pencil, and the rules.

The object of the game is to accumulate the most points. Each player starts with 5 points. Players win or lose points by landing on certain squares on the gameboard. Each square on the gameboard states an environmental practice which a person or city might undertake. The positive practices are rewarded by adding points and the unsound practices cause a player to lose points. A player may also draw a question card from any of the four decks of cards if he lands on a square with a star. If he answers the question card correctly, he earns the number of points designated on the card. One player acts as the "expert" and checks the answers which are found under flaps on the gameboard. The player with the highest number of points when time is called is declared the winner.

PREPARATION: Teachers may want to mount the gameboard on heavy cardboard to make it more durable. The question cards are in sheets of nine which must be cut apart to form the decks. A teacher might also want to mimeograph scoresheets for the game although the score may be kept on plain paper. If tokens are not available from a local store, any small objects (coins, buttons, twigs) can be used to mark students' places.

The rules are simple and easily comprehended. A minimum amount of time will be required for reviewing the rules.

COMMENTS: The **ECOLOGY GAME** was originally designed to be played during the second day of an "Intensive Involvement" field trip. It was also recommended as an excellent way to review environmental facts which might be encountered on a field trip after the students return to the classroom. The question cards emphasize environmental aspects of the air, soil, water, and plant life and their interrelation. If an environmental field trip is planned, this game might be played before or during it to increase students awareness of their environment. It might also be used after the class returns to review the ecological concepts and relationships of the air, soil, water, and plant life.

Time is flexible in this game. The authors recommend from 30 to 45 minutes to complete the game.

TITLE: **ECO-NOPOLY**

GRADE LEVELS: 3rd–6th

PURPOSE: To acquaint the student with the relationship between technology and the quality of the environment.

PLAYING TIME: 1 hour

NUMBER OF PLAYERS: 2 to 4

PRICE: free

DEVELOPER: Jane Hazen

ORDER FROM: Hazen, Jane, "Games in Environmental Education," *Science and Children* 12:22–23 (November–December), 1974.

DESCRIPTION: This game is a board game similar to the game of Monopoly. The board has all four of its corners designated as wilderness areas and these are "safe" to land on. The rest of the squares are known as properties related to the realm of technology. Examples of these properties include oil companies, steel companies, automotive industries, and plastic companies. The companies exist in groupings of one, two, or three depending upon the amount of environmental impact. A three star polluter has the most impact on the environment. The board also has "Eco-risks" chance cards which are detrimental to a player's survival—requiring a player to forfeit survival units for poor environmental practices. However, some of the over 50 cards reward a player for sound environmental practices.

Each player receives a survival kit at the beginning of the game consisting of 1,000 food, 1,000 water, and 1,000 air units. The players purchase the technologies using the survival units. The larger the pollution potential of the industry, the more it costs in survival units. Players landing on the property of another player must pay a fee in survival units. If players run out of one type of survival unit, they may cash in another type at half the value. This causes a player to be penalized for mismanagement of resources.

The winner of the game is the last player to have survival units.

PREPARATION: The teacher must use creativity to construct the playing board, survival units, and "Eco-risks" cards from the descriptions in the article. However, a picture of the gameboard is not provided nor is there a list of possible "Eco-risks" cards even though some concrete examples are mentioned.

COMMENTS: The students should have few problems with the rules, since the game is similar to Monopoly.

It helps to show students that an inverse relationship often exists between technology and the quality of the environment. The "Eco-risks" cards also emphasize many positive and negative environmental practices which the students may practice in real life.

After playing this game, a teacher should point out the fact that any industry can work toward minimizing its impact on nature. The steps taken by industry to reach a harmonious note with the environment and the economic implications of pollution control should also be discussed.

The author suggests a time limit of 1 hour to insure that the game is informative, while maintaining the players' interests. A shorter time period could be agreed upon.

TITLE: **ECOPOLIS**

GRADE LEVELS: 4th–6th

PURPOSE: To give students the opportunity to examine several ecological problems in depth and then attempt to find solutions with which all members of the community can live.

PLAYING TIME: 3 weeks

NUMBER OF PLAYERS: class size

PRICE: $12.00

DEVELOPER: John Wesley

ORDER FROM: Interact, Box 262, Lakeside, California 92040

DESCRIPTION: **ECOPOLIS** is an elementary school adaptation of BALANCE, a secondary simulation by David Yount and Paul DeKock. **ECOPOLIS** begins with a simulation of an ecosystem that existed in western North America over 150 years ago. The students are born as insects, animals, Indians, and pioneers. They must move, die, or adapt to the changing environment brought about by the influx of the American pioneers. Students are awarded GASPS (Goal and Satisfaction Points) at the beginning of each succeeding phase for surviving in the prior ecosystem.

Finally, students become citizens of a contemporary city called Ecopolis. During this phase two problems are investigated: 1) the problem(s) associated with land use and 2) the problems associated with the population explosion. The students take on roles and research possible solutions to the above problems. They become active participants in one of two community meetings that discuss the solutions to the problems above.

PREPARATION: All materials for playing this game are included in the Teacher's Guide. Certain sheets must be duplicated and specific overlay transparencies are also recommended.

COMMENTS: **ECOPOLIS** is an excellent way to examine the problems associated with land use and the population explosion. The game has a definite planned structure but is flexible enough to allow for individual student input. In fact, the game encourages the students to research the topics on their own and go beyond the information provided in the game.

The author recommends a period of 3 weeks for completing the entire game. This time schedule includes two days for working on outside projects. A teacher may want to shorten or lengthen the time depending upon the amount of discussion on each topic and the amount of outside interest shown by the class.

TITLE: **ECOPOLY**

GRADE LEVELS: 4th–12th

PURPOSE: To teach students about positive and negative environmental practices.

PLAYING TIME: 50 minutes to several classes

NUMBER OF PLAYERS: 2 to 6

PRICE: free

DEVELOPER: Raymond Jones

ORDER FROM: Science Education Center, School of Education, Old Dominion University, Norfolk, Virginia 23508

DESCRIPTION: This game is an adaptation of the board game Monopoly. The game kit includes an **ECOPOLY** game board ready for mounting on cardboard, a set of Title Deed cards, a set of Risk cards, and a set of Goodbad cards. It is recommended that these materials be glued on 3 × 5 index cards. The author also recommends using the dice, money, and tokens from a standard Monopoly game.

ECOPOLY has virtually the same rules as Monopoly with a few changes. The layout of the board has been changed. Names of property are different, "Go" has been changed to "Begin," and the "jail" is the "recycling" square. Players buy the various properties for the amounts shown. They also purchase air purification plants (instead of hotels) and water purification plants (instead of houses) to increase the values of their properties. When players go to the recycling square, they are paid $50 and must roll doubles to get off. The Risk cards and Goodbad cards reward participants for sound ecological practices as stated on the cards and penalize participants for harmful practices. The object of **ECOPOLY** is to end the game with the highest value of assets (money and properties) and to bankrupt the opposing players.

PREPARATION: The following items must be mounted on 3 × 5 cards or cardboard before play can begin: the game board, the set of Title Deed cards, the set of Risk cards, and a set of Goodbad cards. Dice, money, and tokens must be made, purchased from other sources, or borrowed from other games.

The rules of **ECOPOLY** are almost identical with Monopoly. Thus, most students will be familiar with the general format and rules. The time for reviewing the game rules should be minimal.

COMMENTS: This game provides an opportunity for students to come into contact with several different positive and negative environmental practices. During this game the participants are rewarded if they happen to choose a card stating a positive practice. A participant also can increase the rent of his property if he has purchased air and water purification plants. On the other hand, the players are penalized if they draw a card stating a negative environmental practice.

This game could last for several hours. However, a teacher can set a time limit for playing the game. Therefore, it is possible for the students to play this game within one class period.

TITLE: EDUVIZ SCIENCE BINGO—ECOLOGY
EDUVIZ SCIENCE BINGO—ANIMAL KINGDOM
EDUVIZ SCIENCE BINGO—PLANT KINGDOM
EDUVIZ SCIENCE BINGO—INSECTS AND SPIDERS

GRADE LEVELS: 7th–12th

PURPOSE: These games are designed to familiarize students with the basic concepts and vocabulary associated with the study of particular areas of biology: ecology, animals, plants, and insects and spiders.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 2 to 16

PRICE: $7.50 per game plus $? for shipping

DEVELOPER: not listed

ORDER FROM: Ideal School Supply Company, 11000 South LaVergne Avenue, Oak Lawn, Illinois 60453

DESCRIPTION: The **EDUVIZ SCIENCE BINGO** series is composed of four different games that use the same "bingo" format. Each of the four games deals with concepts and vocabulary from a particular biological area. **ECOLOGY** deals with concepts and vocabulary associated with an ecological study; **ANIMAL KINGDOM** deals with the various animal phyla; **PLANT KINGDOM** uses terms associated with the study of plants; and **INSECTS AND SPIDERS** utilizes concepts and terms pertaining to these two specific classes of anthropods.

Each game includes the following: 16 bingo cards, 480 plastic discs, and 36 "call-out" cards. Each "call-out" card deals with a term or concept dealing with the specific area of study. For example, in the **INSECTS AND SPIDERS** game, specific insect and spider characteristics, specific insects, parts of spiders and insects, phases of the insect's life cycle, and additional terms are included on the 36 cards. Each of the "call-out" cards includes the column letter, a clue, and the answer. The caller reads the clue and players attempt to find the answer on their bingo card under the correct letter. The answers are marked with the plastic discs. The bingo card has 6 vertical columns with 6 squares under each column. The first person to fill all the squares in a horizontal or diagonal line is the winner.

PREPARATION: All the materials for playing these games are included. A teacher may use them as an introduction to basic concepts or as a review of the basic terms associated with the biological areas.

A limited amount of time would be required if the game was used as a student's initial introduction to the specific terms.

COMMENTS: There are only 16 bingo cards provided with each game. Since many classes are often larger than 16 students, players may be required to team. Another alternative, of course, would be to divide the class and use two or more games.

These games are ideal for introducing or reviewing specific biological terms. They were not designed to deal with the terms in detail. The clues given on the cards consist of only one or two sentences.

These games may be repeated several times during a single class period. This is especially true after the players become acquainted with the concepts and terms.

Additional games may be played with the clue cards. Rules for playing EDUVIZ RUMMY and ADVANCED EDUVIZ RUMMY are also included in each game kit.

TITLE: ENERGY CRISIS GAMEBOARD

GRADE LEVELS: 7th–12th

PURPOSE: To acquaint students with the causes, effects, and possible solutions to energy-related problems.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 4 to 8

PRICE: free

DEVELOPER: Patricia Sommerkamp

ORDER FROM: Sommerkamp, Patricia, "Energy Crisis Gameboard," *The Science Teacher* 42:39–40 (June) 1975.

DESCRIPTION: The following materials must be made by the teacher before this game is played: a gameboard, markers, and question cards (the original had 80 cards). Dice must also be furnished.

There are two methods of playing this game—one method utilizes the question cards while the other only utilizes the gameboard. The gameboard is designed to have numerous squares with instructions on selected squares. To play the game without the cards, each player takes a turn and throws the dice. The player moves the number of spaces on the gameboard that is indicated on the dice. The player follows all directions written on spaces on which he lands. The instructions either move him forward for sound energy practices or backwards for poor energy practices. The winner is the first player to reach the winner's circle.

When the question cards are used, they are placed face down on the gameboard. Each player rolls the dice and the player to his left selects the top card and reads it. If the player who rolls the dice is able to answer the question correctly, he advances the number indicated on the dice. If he is unable to answer the question, he must remain in his original position. The answers are written on the bottom right corners of each card. The first player to reach the FINISH circle is the winner.

PREPARATION: The teacher or the class must design and make the gameboard, markers, and question cards. It is possible to play one version of this game without the question cards. The author let her classes design the game as a culminating activity to an energy study. The students used the concepts which they learned during their research to design the question cards and gameboard. A similar approach might be used by other teachers.

COMMENTS: A description of this game is included in the journal article. However, a teacher and her students must use their own imaginations to devise the gameboard, markers, and question cards. No specific details about the gameboard layout are provided in the article. Examples of instructions for the gameboard squares are given but others must be devised by the designers.

The game seems to be an excellent culminating activity for an energy study.

TITLE: THE ENERGY-ENVIRONMENT GAME

GRADE LEVELS: 7th–12th

PURPOSE: To consider society's demand for energy, its potential impact on the environment, and possible trade-offs.

PLAYING TIME: 5 to 7 class periods.

NUMBER OF PLAYERS: 32

PRICE: $26.00

DEVELOPER: Creative Studies, Inc.

ORDER FROM: Edison Electric Institute, 90 Park Avenue, New York, New York 10016 or Your local power company

DESCRIPTION: **THE ENERGY-ENVIRONMENT GAME** consists of the following: 32 player's guides, one teacher's guide, one filmstrip and record; 2 sets of 32 role cards, site selection information, one wall map, and 8 packets of resource information for the library.

This game is an educational simulation that deals with society's demand for increasing amounts of energy and the complex problems that result from this demand. The actual play of the game revolves around an electric utility company's request to build a new power plant. Players assume roles ranging from the utility company president to the leader of an environmentalist group opposed to new plant construction. The various players present their views at a governor's commission hearing which is considering the plans and a site for a new plant. Later the players join task force groups to help select possible trade-offs involved in meeting society's demand for more energy.

The game concludes with the governor's commission making its formal recommendation concerning the need for and site of a new plant.

PREPARATION: All materials required for playing **THE ENERGY-ENVIRONMENT GAME** are included in the game kit.

COMMENTS: This educational simulation is extremely well planned and designed.

If a teacher has not had any experience with an educational simulation, the thoroughness of this game and the conciseness of its directions would make it an ideal one with which to gain experience.

The game was designed to be completed in five to seven class periods although more or less time may be required, depending upon the maturity of the group.

TITLE: ENERGY X

GRADE LEVELS: 6th–12th

PURPOSE: 1) To create an awareness of need for the intelligent use of energy in its many different forms, 2) to create an awareness of the concept of non-renewable resources, 3) to provide a classroom environment in which students learn relationships between locations of major resources, population, regional differences, and related economic situations, 4) to provide students with experience in group dynamics different from that inherent to the typical classroom, and 5) to encourage student awareness of their "real world", responsibility in dealing with the energy crisis.

PLAYING TIME: 3 class periods

NUMBER OF PLAYERS: class sizes (20 to 40)

PRICE: $19.50 plus 5% shipping

DEVELOPER: Norman S. Warns, Jr.

ORDER FROM: Ideal School Supply Company, 11000 South Lavergne Avenue, Oak Lawn, Illinois 60453

DESCRIPTION: This game could be called a highly-structured simulation with roles. The game kit includes: a filmstrip with tape narration; group markers; five cut stencils including Regional Analysis Worksheet, Presentation Organizer, Student Self-Evaluation Form, Roster for Student Roles, and Advantages and Disadvantages of Energy X; 10 sets of colored charts giving basic population, resource distribution, and energy use information for each region (each set consists of 8 pages); and a teacher's manual.

ENERGY X centers around an unusual scientific phenomenon. A meteorite, containing a little understood material named Energy X, strikes the earth. Energy X is a universal power source. However, only enough of this material could be recovered from the meteorite to serve three regions (the Congress has divided the U.S. into eight distinct regions for this game) for a period of three years.

The class is divided into nine groups in order to play this game. Eight of these groups represent the eight regions and the ninth group is designated as the Project Control Group. The game is played in four phases. Phase I is the "Fact Finding and Planning Subcommittee" phase. In this phase the eight regional committees gather data to support the claim that Energy X should be used in their region. In the

second phase, each committee's argument is presented to the members of the Project Control Group. In Phase III, the Project Control Group decides which three regions should receive Energy X. This verdict is presented to the entire class with an explanation for the decisions. The fourth phase is optional and involves an appeal by the various regional committees. The game ends with a teacher-led debriefing session in which the class considers parallel aspects of the simulation with the current situation in the world today.

PREPARATION: All materials for playing this game are included in the packaged game kit. A teacher should read over the rules and map out a daily lesson plan for the simulation (a three-day lesson plan is suggested in the teacher's manual). A filmstrip projector and cassette tape player must be obtained in order to introduce the simulation. The stencils for the game must also be duplicated.

COMMENTS: **ENERGY X** is a well-designed instructional simulation. While playing this game the class should examine energy allocation from a number of different angles—population, occurrence of natural resources, farming and manufacturing potential, present energy consumption, and mobility (cars, trucks, buses, and roads in each region) considerations of each specific region.

The game is highly structured because it provides guide sheets for analyzing a region's assets and debits for energy allocation. A guide sheet for preparing a region's presentation is also included in the game. This sheet asks specific questions which help the representatives of each region point out the reasons why Energy X should be allocated to their region.

The game also includes a self-evaluation form for each student. This form emphasizes the students' view of how well each person played the game. It also places emphasis on the important values and attitudes which a person needs in order to make important environmental decisions.

TITLE: ENVIRONMENTAL REALITIES

GRADE LEVELS: 1st–12th

PURPOSE: The following are listed as the purposes of the game: 1) to develop an awareness of the realities of the modern city, 2) to gain a deeper understanding of and appreciation for the city, 3) to develop an awareness of problems of the city, 4) to develop an awareness of the people who live and work in the city, 5) to think of possible remedies for urban problems, and 6) to provide an opportunity to express values and to organize and evaluate ideas as they apply to the city.

PLAYING TIME: 1 to 3 hours

NUMBER OF PLAYERS: 4, 5, or 6 (or this many teams)

PRICE: free

DEVELOPER: not listed

ORDER FROM: Your local Civil Defense Preparedness Agency

DESCRIPTION: This game consists of a gameboard with actual pictures of the city, four decks of cards (Situation, Action, People, and Chance), and a rules booklet.

Players move around the board by using a spinner or rolling a die. The player advances the number of spaces indicated and selects the appropriate card from the top of the deck. They may land on a people, situation, or action space. The people cards present questions that will require the player to identify with the person pictured on the gameboard. The situation cards present problem areas associated with the city that require players to think of one step toward a solution of the problem. Action cards give the players authority, power, or a position through which they are required to solve certain urban problems. The chance cards give the players an opportunity to either gain or lose points. A player may draw a chance card twice.

After drawing a card, players have 30 seconds to formulate a response. The other players vote to see if they agree with the answer given. If all players agree, points are awarded to the player who gave the correct answer. Each type of card has a specific point value. If players disagree with an answer, they cast a "veto" and tell why they disapprove of the response. A second, final vote is then taken. The player may receive all or part of the total possible score depending on the vote of the group. In case of a tie vote, the player does not score.

The game is completed when: 1) one player has gone around the board once; 2) a set time has passed, or 3) a set number of points are reached. The player with the highest total score wins.

PREPARATION: The game kit includes the gameboard with actual photographs, the cards, and the rules booklet. The cards must be separated before play starts. The teacher may also want to mount the gameboard on heavier cardboard. The teacher must provide the markers for each player and a spinner (or die) for each game.

COMMENTS: This game is most interesting for two specific reasons. First, the game insures total participation at all times by requiring players to vote after each question. Second, the game requires the students to discuss actively questions that will require value judgments.

The time for playing this game could vary considerably. The two major factors determining the time include: 1) the amount of discussion between each question and 2) the rule determining the end of the game. Of course, a teacher could always terminate the game after a specified time.

TITLE: **EXPLOSION**

GRADE LEVELS: 7th–12th

PURPOSE: To experience the problems of the population crisis and its social, environmental, and political impact on a finite system such as the Earth.

PLAYING TIME: 5 weeks

NUMBER OF PLAYERS: class size

PRICE: $20.00

DEVELOPER: Dan Guida, Roger Henke, and Dennis Porter

ORDER FROM: Interact, P. O. Box 262, Lakeside, California 92040

DESCRIPTION: **EXPLOSION** is a simulation game in which the students role-play inhabitants of a hypothetical country named Scioto. During this game the students encounter various environmental, social, and political problems associated with population. The game is divided into three phases: 1) social pressures, 2) PACFOS, and 3) governmental decision-making. During Phase I each student becomes a member of one of Scioto's six states. Each student is assigned three research assignments on his particular state. Food coupons are awarded for the completed assignments.

During the second phase each student becomes a member of a State Planning Agency (SPA) and a Special Interest Group (SPIG) at the same time. Each student must represent the interests of each group represented as plans are devised for Scioto's natural resources. Each SPA chooses a member to represent its views on the President's Advisory Council for the Future of Scioto (PACFOS). The members debate the issues and compile a final set of recommendations.

Phase III involves the students in roles of concerned citizens from one of Scioto's six states. Citizens from each state devise a federal bill attempting to solve the population-related problem associated with their state. The bills must pass both Senate and House in order for Scioto's president to act on the bill.

The game ends with a two-day debriefing session in which the problems of Scioto are related to the problems of the real world.

PREPARATION: All materials for playing this game are included in either the teacher's guide or student guide. Some materials must be duplicated from the teacher's book. The teacher's guide specifies which materials are to be duplicated and the number of each item.

COMMENTS: **EXPLOSION** is a multi-disciplined game touching upon the social, political, and environmental aspects of the population crisis. This approach emphasizes that population problems do not have simple, straight-forward solutions.

The hypothetical, closed system of Scioto can easily be related to our own Spaceship Earth since both have limited resources and cannot support an infinite population. The debriefing session of this game is one of its most important parts. It is during this session that the experiences of the game are related to the actual problems associated with the Earth's population.

The time schedule for this game involves a five-week period for all three phases of **EXPLOSION**. However, the authors have designed the phases so that each one may be used independently. The authors recommend that the numerical order of the phases not be interrupted (when using more than one phase) and that a debriefing session be included in the game no matter how many phases are used. The time period for playing **EXPLOSION** could vary from one week to five weeks depending upon the phase(s) chosen.

TITLE: **FOOD CHAIN**

GRADE LEVELS: 7th–10th

PURPOSE: To reinforce the concept of food chains by building specific 6-member chains for a community.

PLAYING TIME: 50 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: contact publisher

DEVELOPER: Harry Wong, Leonard Bernstein, and Edward Shevick

ORDER FROM: Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

DESCRIPTION: The game consists of 60 cards, each representing a specific organism or the sun. There are a total of 5 different, 6-member chains that can be put together using the deck.

The cards are shuffled and each member is dealt five cards. One card is turned face up next to the remaining cards. This gives the players a draw pile and a discard pile.

The player on the dealer's left picks up the top card from either pile. He then discards a card (except when he wins). The winner is the first player to lay down six cards belonging to one food chain. The cards must be placed down in the correct order to win.

PREPARATION: No preparation is necessary in order to play the game. The five possible food chains should be written on a paper and passed out to all players or written on the blackboard. These may be obtained from *Life Science: Ideas and Investigations in Science* by Harry Wong, Leonard Bernstein, and Edward Shevick.

COMMENTS: **FOOD CHAIN** is an excellent way to reinforce a student's concept of a food chain. Other items might be noted by the students while they play the game: 1) a food chain usually begins with the sun's energy, 2) the direction of the energy flow in a food chain, and 3) an organism may belong to more than one food chain.

Prentice-Hall does recommend that this game be used in conjunction with the HS program.

The game is designed to be played within a single 50-minute period. As the players become more proficient with the rules, time for each play will decrease.

TITLE: FOREST ADVENTURE

GRADE LEVELS: 4th–8th

PURPOSE: To help students recognize the value of natural resources, to acquaint them with the interdependence of forest regions, and to learn about the propagation and commercial uses of trees.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 5 or 5 groups

PRICE: ERIC charge

DEVELOPER: Pennsylvania State Department of Education

ORDER FROM: Ed 081 595, ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1200 Chambers Road, Third Floor, Columbus, Ohio 43210

DESCRIPTION: Detailed instructions are given for the collection and construction of the necessary components. These include white poster board (eight sheets, 22″ ×28″), felt-tip markers, 5 wooden cubes, 3 wooden disks (5″ in diameter), index cards, glue, nails, masking tape, toothpicks, and construction paper.

The playing board is a map of the U. S. with five forest regions outlined, colored, and labeled. Five forest trails, each with 25 spaces lead to the 5 forest regions. The three disks, made into spinners, have "situation" phrases printed on them so that at each spin a player gets his instructions from the spinner.

To play, 5 students or 5 teams are each assigned a forest and each must begin on the trail leading to the forest. The player's wooden cube is placed at start and, in turn, each spins spinner #1. Upon reaching his forest, the player switches to spinner #2 and when "you are a full grown tree" is obtained, spinner #3 is used. This spinner is a "commercial use" challenge for which each correct response is awarded a Commercial Use Card.

The winner is the first player to receive 2 Commercial Use Cards.

PREPARATION: No preparation is required to play this game although the leader does have a number of construction tasks prior to playing the game. In most cases, students can do most of the work.

COMMENTS: A very good game to use with students studying the forest environment. The game is challenging and can be modified to

meet group characteristics. It can well serve as focal points for group discussions of forests, natural resources, forestry, wood uses, and the like.

One class period is required to play but the game can be repeated.

TITLE: **FOXES AND RABBITS**

GRADE LEVELS: 4th–12th

PURPOSE: To teach students the concept of predator-prey relationships and how various organisms interact in these relationships.

PLAYING TIME: 50 minutes

NUMBER OF PLAYERS: 1 player per game set

PRICE: free

DEVELOPER: not listed

ORDER FROM: Science Education Center, School of Education, Old Dominion University, Norfolk, Virginia 23508

DESCRIPTION: This game kit gives instructions for making the necessary components. These materials are needed: masking tape, a meter stick, 300 small squares, 1 large weighted square, a data sheet, and a pencil.

The game is started by marking off a 60 cm square playing area with masking tape. This represents a player's woodland. The player begins with 3 rabbits and 1 fox. He or she tosses the rabbits into the square and standing one meter away tosses his fox into the ring. The fox captures all the rabbits that he lands on. Rabbits not captured by the fox remain in the square and double in number. If the fox captures 3 rabbits, it lives and gives rise to a new fox. If it fails to land on three rabbits, the fox dies of starvation. The data is recorded on the data sheet. The game lasts for 15 generations of foxes and rabbits.

PREPARATION: The preparation for this game involves the making of 300 small squares to represent the rabbit population and one large weighted square for the fox. The teacher must also have a data sheet prepared for each student plus masking tape and meter sticks for the entire class.

COMMENTS: This is a short exercise that illustrates a specific concept. The most important aspect of the game is the actual interaction of the two populations. The students should have a better understanding of this interaction after this exercise.

This game can be completed within a 50 minute period but may be shortened for a flexible schedule by stopping before 15 generations are completed.

TITLE: FRUSTRATION: A WASTEWATER TREATMENT GAME

GRADE LEVELS: 5th–10th

PURPOSE: To help students better understand and appreciate the difficulty encountered when necessary public service endeavors are undertaken in various communities.

PLAYING TIME: 15 to 20 minutes

NUMBER OF PLAYERS: 4 or 5

PRICE: unknown

DEVELOPER: Clifford Gale

ORDER FROM: Found in: Coates, D. *Environmental Science Workbook*, S. U. N. Y., Binghamton, New York or Mr. Clifford A. Gale, Cazerovia High School, Cazerovia, New York 13035

DESCRIPTION: Instructions are provided, but materials must be collected or constructed. Game materials include a game board, 5 player markers, and a die. The game board is made by fastening together five sheets of paper, each with one part of the game printed on it. These sheets may then be glued to a rigid board (plywood or particle board) for a more permanent playing surface.

The object of the game is to construct a wastewater treatment plant. As the gameboard "progresses," one goes through the construction steps from the initial engineering report to opening an operational plant with tax increase struggles and worker strikes in between.

The winner is the first player to reach the "Plant In Operation" square.

PREPARATION: No student preparation is required to play; teacher preparation will be necessary to construct the game board and locate markers the first time the game is used.

COMMENTS: This game has been organized to serve as the culmination of a study of water treatment, trying to impress upon the students the difficulties in getting a project such as this started and through the many steps to completion. The game will do a good job of meeting the objectives if the teacher conducts meaningful discussions prior to and following the game.

TITLE: A GAME FOR CLASSIFYING ANIMALS

GRADE LEVELS: 4th–6th

PURPOSE: To provide opportunities for students to construct and analyze a classification system for animals.

PLAYING TIME: varies; 15 to 45 minutes

NUMBER OF PLAYERS: any number (20 to 35)

PRICE: free

DEVELOPER: Harrie E. Caldwell and Susan Patsko

ORDER FROM: Instructions and other details may be found in *Science and Children*, Vol. 12, No. 8, (May) 1975, pp. 23–25.

DESCRIPTION: The only materials required are slips of paper on which certain kinds of information must be printed. Each slip contains information about a single animal on one side and the name of the class to which the animal belongs on the other side. A complete set consists of 30 slips, 6 for mammals, 6 for fish, 6 for birds, 6 for amphibians, and 6 for reptiles. Each student, pair of students, or other group must have a complete set of slips.

The purpose of the game is to classify correctly the animals on the slips of paper, having various types of competitions in the process.

COMMENTS: If an objective is to learn to classify animals, this game suggests another alternative approach. The teacher or aid must prepare the slips of paper and the nature of the competition must be established (a race to finish; the most correct in 15 minutes, etc.).

There are many variations possible, the number being determined by the creativity of those using the ideas.

Time required for this game varies greatly with the type of group, but the teacher can easily control this by changing some of the requirements (i.e., classify correctly 3 of the 5 groups instead of all 5).

TITLE: **BLOOD FLOW**

GRADE LEVELS: 7th–12th

PURPOSE: To provide opportunities for students to learn the various components of the circulatory system and the various "troubles" that can befall a red blood cell.

PLAYING TIME: 45 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $10.00

DEVELOPER: Rosette Dawson

ORDER FROM: Rosette Dawson, 1015 Whitestone Lane, Houston, Texas 77090; Discovery Corner, Lawrence Hall of Science, University of California, Berkeley, California 94720

DESCRIPTION: The game consists of a gameboard, die, disk-shaped playing tokens, white tokens, black tokens, and Blood Flow cards. The gameboard is in the shape of a human figure. It indicates the flow of blood through the main arteries and veins of pulmonary, systemic, and portal circulation. Statements found on the board inform each player what is happening to his corpuscle. Each player is designated by a corpuscle-shaped disk representing a red blood cell. Oxygen is represented by white tokens and black tokens represent carbon dioxide molecules. The Blood Flow cards provide countermeasures for events occurring along the gameboard.

The object of the game is to be the first red corpuscle to pick up oxygen from the lungs, exchange it for carbon dioxide in a capillary bed, and return to the right atrium of the heart. Each player starts in the right ventricle of the heart and rolls the die to determine his capillary bed destination—head, arm, kidney, small intestine, large intestine, or leg. After the capillary bed destination is established for each player, they proceed around the playing board. Certain spots on the playing board represent various medical problems that can happen to a red blood cell. The players must successfully negotiate their pathways and return to the right atrium of the heart to be declared the winner.

PREPARATION: All the equipment needed to play **BLOOD FLOW** is included in the game. Students should probably be introduced to the circulatory system before playing the game because this would lead to a better understanding of the game rules and directions. Thus,

BLOOD FLOW would be excellent for reinforcing certain concepts about the circulatory system that have been discussed by the teacher.

COMMENTS: If students play this game, they will be exposed to the following: 1) the major parts of the circulatory system, 2) the general direction of the flow of blood in the body, 3) many medically-sound situations which can destroy the red blood cells, 4) means of combating the "medical" situations, 5) the sites of production of the red blood cells in the body, and 6) the sites of exchange of oxygen and carbon dioxide in the body.

The game is fast moving and there are several situations that require players to begin again at start.

The gameboard and situations are scientifically correct. The gameboard's shape (like a human figure) adds a real dimension to the game and students can actually see where each artery and vein is located. Students can also see the sites of carbon dioxide and oxygen exchange.

The game should not take more than 45 minutes to play after the players became familiar with the rules. For maximum benefit the students should repeat the game several times.

TITLE: GEOLOGIC TIME CHART GAME—EVOLUTION

GRADE LEVELS: 4th–12th

PURPOSE: To teach the players the eras and periods of geologic time and how the evolutionary forces act on populations to cause survival or disappearance.

PLAYING TIME: 40 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $12.50 or 5 copies for $55.00

DEVELOPER: Paul F. Ploutz

ORDER FROM: Union Printing Company, Inc., 17 West Washington Street, Athens, Ohio 45701; Damon/Education Division, 80 Wilson Way, Westwood, Massachusetts 02090

DESCRIPTION: GEOLOGIC TIME CHART GAME consists of a large playing board, 6 plastic tokens, 100 population chips, 1 die, 32 "Evolution" cards, 26 "Chance" cards, and a plastic storage box. The playing board is a simplified version of the Geologic Time Chart and is divided into 5 eras: Archeozoic, Proterozoic, Paleozoic, Mesozoic, and Cenozoic.

The main object of the game is for players to evolve into higher forms of animals as they pass from one era to the next. Players increase their population totals by answering the "Chance" cards correctly or selecting specific "Evolution" cards favorable to population growth. The first player to become a monkey or a man is the winner of the game regardless of population numbers. If none of the players evolve into monkeys or man, the player with the largest population is the winner.

PREPARATION: All the materials for playing the game are included in the kit. Students need not know all of the factual information asked on the "Chance" cards. The game board is printed with answers incorporated. The students can answer the questions by studying the information on the board; thus, teachers do not have to present all the information to their students before the game is played.

Teachers should take time to review the rules with their students before play.

COMMENTS: The following factual information is included in the "Chance" cards: 1.) the names and numbers of eras in the time chart,

2) the periods in each era, 3) the length and sequence of the eras, and 4) the animals which evolved in each era. The "Evolution" cards show that environment, food, genetic mutations, and other populations have an effect on the evolution of a species. Extinction is also discussed as a part of the evolutionary process.

This game is an excellent way to get students involved in actively learning a large mass of technical information on the Geologic Time Chart.

Students who are proficient with the rules of the game and the information found on the Geologic Time Chart take between 35 and 40 minutes to play the game. The initial playing of the game tends to take 10 to 15 minutes longer.

TITLE: GOMSTON—A POLLUTED CITY

GRADE LEVELS: 7th–12th

PURPOSE: 1) To generate a concern and understanding of the problems of environmental degradation in GOMSTON, 2) to provide insight into the possible solutions to the environmental problems and the effects of the solutions, 3) to create a classroom situation in which the problems of environmental degradation are analyzed, and 4) to foster an understanding and awareness of the "real world" situation.

PLAYING TIME: at least 5 class periods

NUMBER OF PLAYERS: class size (20 to 40)

PRICE: $25 plus 5% shipping

DEVELOPER: Norman S. Warne Jr.

ORDER FROM: Ideal School Supply Company, 11000 South Lavergne Avenue, Oak Lawn, Illinois 60453

DESCRIPTION: **GOMSTON** is an environmental simulation. The game kit includes the following: two wall posters—one "before" and one "after" pollution has been remedied; two transparencies of a map of Gomston; committee nameplates with goals written on the back; a filmstrip with tape narration; 40 copies each of five different handouts, including the Gomston map; a letter from the local geographer describing water and air pollution causes in Gomston; Gomston environmental analysis questions; a test on Gomston's pollution problems; a student self-evaluation form; and a teacher's manual.

The class is divided into eleven different groups, which include representatives from the following areas: state and local government, local industry, agriculture and lumber, forestry and wildlife, chamber of commerce, environmentalists against pollution, and the local news media.

To begin the game, students discuss the characteristics and statistics of Gomston. The environmental problems of Gomston and causes of these problems are then discussed. The students divide up into their individual groups to plan their strategy, based on their individual goals. A meeting of the town council is then called by the mayor. The environmental alternatives to correct these problems are discussed and voted upon. Without warning, the teacher calls an end to the simulation. Student and teacher evaluations follow. A summary dis-

cussion may follow the game relating the knowledge learned in the simulation to the students' local community.

PREPARATION: The author suggests that **GOMSTON** be played after the teacher has presented the facts of environmental pollution to the class. Some teachers, however, may want to use **GOMSTON** as an introduction to a pollution unit.

All materials for playing the game are included. A filmstrip projector and cassette player are necessary for this game. The rearrangement of the classroom furniture might also be necessary when the city council meets.

COMMENTS: **GOMSTON** is a well designed environ- simula-tion. Enough informational material is included with the order to play it without outside references. For those who wish efer to outside sources, there is a selected bibliography in the teacher's manual.

TITLE: GROUP 'EM

GRADE LEVELS: 5th–10th

PURPOSE: To provide opportunities for students to learn more about the major groups of animals and some of the group's characteristics.

PLAYING TIME: 30 minutes

NUMBER OF PLAYERS: 3 to 6 (6 recommended)

PRICE: $2.50

DEVELOPER: not listed

ORDER FROM: The Fun Time Company, 1374 Glenrock Drive, Maryland Heights, Missouri 63043

DESCRIPTION: Game materials include a deck of 54 cards composed of 6 sets of 9 each with each set having a different numerical value. The 6 sets represent 6 groups of animals—fish, amphibians, reptiles, birds, mammals, and man.

To begin, each player chooses a set of cards: with 6 players use all cards with 5 players, discard the lowest set; with 4, the 2 lowest sets; and with 3, the 3 lowest sets. Next, all of the cards to be used are shuffled and dealt to the players; each player should have 9 cards. The dealer shouts "group 'em" and all players begin to trade any number of like cards for the same number of like cards. All trading is without knowledge of the kinds of cards the player will receive in trade.

The winner is the first player to get a set of like cards.

PREPARATION: No preparation is required to play the game; some discussion of the various groups of animals may be helpful.

COMMENTS: Students should enjoy this game and may learn something about the groups of animals even without class discussion.

The game is "noise producing" so students may need to play in a room by themselves or outside.

TITLE: HAWK AND FIELDMOUSE GAME

GRADE LEVELS: 5th–7th

PURPOSE: To teach the predator-prey relationship and how these populations affect one another.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 1 or a small group (2–4)

PRICE: contact publisher

DEVELOPER: Harry Wong, Leonard Bernstein, and Edward Shevick

ORDER FROM: Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

DESCRIPTION: This game consists of twenty "Hawk" cards and two hundred "Fieldmice" cards. To play, a student marks a 60 cm square area on the floor to represent the community of the hawk and fieldmice. A line is drawn one and a half meters from the edge of the square. Five "fieldmice" cards are placed inside the square to represent the initial mice population. A player stands behind the line and throws a "hawk" card into the square trying to make it land on as many "mice" cards as possible. If a "fieldmouse" card is touched, it is considered caught. The player removes the "hawk" and any "fieldmouse" cards that are caught.

In order to live, a hawk must capture four fieldmice or it dies from lack of food. For each four fieldmice caught, the hawk will reproduce another hawk. The fieldmice left will double with each generation. The hawk population does not drop below one. The game is played for 20 generations and the populations are recorded after each generation.

The above rules are not included with the game but are found in LIFE SCIENCE—IDEAS AND INVESTIGATIONS IN SCIENCE by Wong, Bernstein, and Shevick.

PREPARATION: Twenty "Hawk" cards and two hundred "Fieldmice" cards are included in the game set. The square and lines must be measured; however, this could be done by the students to improve their metric measuring skills.

The rules for keeping score of the populations should be reviewed extensively with the students. The teacher might also be on hand to help any students who are having problems with the scoring.

COMMENTS: This game provides an opportunity for students to study population dynamics in an active way. Students get to observe the fluctuations in the predator and prey populations. They can use the data to actually compare the changes in the two populations. If a teacher so desires the data may also be put into graphs for a visual comparison.

The mechanics of this game are relatively simple—the tossing of cards. However, the concepts taught are basic to any ecological study. The scoring of the populations may present problems for some students so teachers may want to be especially attuned to this point at the beginning of the game.

Prentice-Hall does recommend that this game be used in conjunction with the IIS program.

This game should not be rushed. The results should be closely analyzed to determine the relationships between the two populations. The playing of the game may take one period and the analysis a second period.

TITLE: HS HOMEOSTASIS CARDS AND BOARDS

GRADE LEVELS: 10th–12th

PURPOSE: To summarize the concept of homeostasis.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 2 to 4

PRICE: contact publisher

DEVELOPER: Harry Wong and Marvin Dolmate

ORDER FROM: Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

DESCRIPTION: This game has a gameboard and a deck of 114 cards. The cards include stimulus cards, response cards, and caloric cards. The gameboard shows six different body parts—stomach, small intestine, large intestine, heart, lung, and nervous system. The object of the game is to be the first player to place 400 calories under each body part.

The game begins by dealing each player six cards and placing the remaining cards in the center of the table. Each player takes a card from the deck and makes a play. Players may do one of four things: 1) they may add a caloric card under any of the body parts, 2) they may place a stimulus card on any of the body parts of an opponent, 3) they may place a response card on top of a stimulus card to correct the upsetting condition, or 4) they may discard a card next to the pile.

If an opponent places a stimulus card on another player's space, that player cannot place any calories on that body part until he has placed the correct response card on top of the stimulus card.

To win, a player must place exactly 400 calories under each body part.

PREPARATION: All materials for playing this game are included in the game kit. The rules are not included in the game but are found in **IDEAS AND INVESTIGATIONS IN SCIENCE—BIOLOGY** by Harry Wong and Marvin Dolmate.

The rules are clearly written and should be easily understood by the average student.

COMMENTS: This game shows that the body requires energy to maintain metabolism in all parts of the body. It also shows that certain

stimuli can upset the body's steady-state and certain conditions help to balance the upsetting stimuli.

Prentice-Hall does recommend that this game be used in conjunction with the IIS program.

TITLE: INDIAN VALLEY

GRADE LEVELS: 7th–12th

PURPOSE: To give students an opportunity to put into practice some of the principles which professional forest land managers employ.

PLAYING TIME: 2 to 5 class periods

NUMBER OF PLAYERS: class size (24 to 36)

PRICE: free

DEVELOPER: Norman C. Thomas

ORDER FROM: American Forest Institute, 1619 Massachusetts Avenue, N.W., Washington, D. C. 20036

DESCRIPTION: This game kit contains the following items: 1) a master sheet showing "Indian Valley," 2) a master sheet for each of the resource teams listing the objectives for that group and some general principles of land management, and 3) a master sheet listing instructions for the multiple-use committee and worksheet for scoring.

The game is played by dividing the class into six groups. The following groups are represented: 1) Water Resources, 2) Parks and Recreation Resources, 3) Timber Resources, 4) Fish and Game Resources, 5) Fire Protection, and 6) Multiple-Use Committee. Each committee is charged with developing a plan for Indian Valley representing their special group. Each committee selects three major projects and develops their reasons for wanting these projects enacted. After each of the five teams develops their plans, they present them to the Multiple-Use Committee. This committee selects ten out of the fifteen projects submitted to comprise a master plan for Indian Valley.

A team is awarded 10 points for each project approved by the Multiple-Use Committee. A team may also be awarded 2 points if one of its projects earlier denied is proposed and approved for another team. The team with the most points wins.

PREPARATION: The master sheet showing "Indian Valley" should be reproduced for each student. One transparency of the map should also be made for use on the overhead projector.

Each member of each resource team should receive a list of that team's objectives and management principles. These may be copied from the original game sheets.

Copies of the instructions for the Multiple-Use Committee and

worksheets for scoring each team's performance should be made for each member of this committee.

COMMENTS: **INDIAN VALLEY** gives the students an opportunity to utilize sound land management techniques in order to develop a plan for a natural area. Negotiation and bargaining are an important part of the game for its participants. After playing this game, the participants should be able to judge some of the land-use issues which might arise in their future.

TITLE: MAKE YOUR OWN WORLD

GRADE LEVELS: 4th–12th

PURPOSE: To teach students that all elements of the environment are interrelated and interdependent. It also teaches that changes have consequences not only for man but for other forms of life and for soil, air, and water.

PLAYING TIME: 30 minutes to 3 hours

NUMBER OF PLAYERS: classroom size to be divided into 11 groups

PRICE: free

DEVELOPER: not listed

ORDER FROM: Science Education Center, School of Education, Old Dominion University, Norfolk, Virginia 23508

DESCRIPTION: **MAKE YOUR OWN WORLD** is a kit designed to enable teachers to make their own materials based upon the Coca-Cola Company's **MAN IN HIS ENVIRONMENT.** This kit includes mimeographed materials for making the following: one "Make Your Own World" chart; 10 Project Proposal cards; cards simulating population, sewage disposal plants, a dump; and 11 Team Identification Cards.

At the beginning of the game each student is assigned a role. The roles include three basic types: human, organism, or natural resource. The students are presented a chart representing the natural area for their own world. The game proceeds by presenting a series of proposals about adding man-made projects to their world. Each project is analyzed according to the students' roles and each proposal has a list of items to consider concerning the impact of the project. After the discussion, a vote is taken to determine whether it should be added. If the project *is* added, a given number of population squares are also added to represent the population increase brought about by the project. The game ends when all the projects have been considered.

PREPARATION: The teacher is responsible for making the following items: the game chart; the simulation cards for population, sewage disposal plant, a dump; Project Proposal cards, and Team Identification Cards. All the information for making these materials is included in the kit.

COMMENTS: **MAKE YOUR OWN WORLD** is a game filled with classroom discussion and debate about many of the man-made projects

we take for granted in our everyday lives. In many instances this game may be a student's first opportunity to consider the importance of such projects and their effects. The game may not be realistic from the standpoint that organisms (deer and forests) and natural resources (soil and air) are given an opportunity to vote on a man-made project. However, this aspect may foster a deep concern for the various parts of our natural environment.

The instructions for this game suggest a minimum of 50 minutes and a maximum of four to five hours. The time would depend heavily on the amount of class discussion generated by each proposal. It was also pointed out that this game can be easily interrupted at several points and continued at a later time.

TITLE: MAP-O-RAMA

GRADE LEVELS: 5th–7th

PURPOSE: To teach youngsters map reading skills in population, natural resources, political, products, geographic relief, and precipitation.

PLAYING TIME: 30 to 60 minutes

NUMBER OF PLAYERS: 6 to 36

PRICE: ERIC charge

DEVELOPER: Pennsylvania State Department of Education

ORDER FROM: ED 081 595, ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1200 Chambers Road, Third Floor, Columbus, Ohio 43210

DESCRIPTION: The only materials provided are printed descriptions of the game from which one may make required game components as well as organize and play the game. Materials needed include 36 3″ × 5″ index cards, four large pieces of poster paper, one wooden cube ½″ square on each side, six model cars, a large map of the U. S., and sets of the following maps: political, precipitation, products, population, graphic relief, and natural resources.

The large U. S. map serves as a group game board with a six-lane highway extending from coast to coast. Each lane is divided into 25 equal segments and each has a string track running down the center along which model cars can move. On each of the 36 index cards is printed or typed one question.

To play, the class is divided into groups of 6 students each. One student selects a card from the "deck" and if answered correctly, gets to roll the cube ("mil-o-cube") to see how many miles the team auto moves along the highway. Play moves from group to group with each student in each group having a turn.

The auto to reach the opposite coast first wins the game.

PREPARATION: Very little preparation is required for students to actually play the game but there is a lot to be done prior to the activity by the teacher or others interested in organizing for the game.

COMMENTS: A key to the success of this game may well be the caliber of the questions on the card deck. These must be good questions, pertinent, relevant, and a challenge to the players.

TITLE: MEET SEYMOUR SAFELY

GRADE LEVELS: K–2nd

PURPOSE: To involve the young reader actively in an understanding of eye care and safety.

PLAYING TIME: several class periods

NUMBER OF PLAYERS: entire class

PRICE: $1.00

DEVELOPER: American Optometric Association

ORDER FROM: Optometric Development Enterprises, 7000 Chippewa Street, St. Louis, Missouri 63119

DESCRIPTION: **MEET SEYMOUR SAFELY** is actually not a single game but an activity booklet. The American Optometric Association has developed a cartoon character named "Seymour Safely" to introduce small children to eye care and safety. The booklet is filled with ideas, activities, skits, and games emphasizing the importance of good vision and eye safety. The booklet is fully illustrated and provides teachers with all the needed information to conduct the activities.

MEET SEYMOUR SAFELY has a section of nine games which encourage the students to have fun with their eyesight.

These games emphasize the development of motor coordination, spatial relationship, visual perception, visual discrimination, observation of colors and forms, integration of visual conceptual and spatial relationships, discrimination of forms, visual-motor responses, spatial awareness, and the estimation of measurements of sizes and distances.

PREPARATION: Most of the above games require very little preparation. They utilize items and objects found in the elementary classroom. If a master is required for a game, a picture of it is supplied in the booklet. Other games require such things as pieces of string, pieces of colored paper, and a mirror.

COMMENTS: This activity booklet suggests excellent ways for teachers to involve students in fun activities that emphasize the development of certain visual skills. Activities for the pre-school age child emphasize the development of visual perception and discrimination of colors and forms.

The games for the older children (grades 1 and 2) stress the devel-

opment of higher order visual skills. Students must integrate visual, spatial, and conceptual relationships.

The authors of this booklet point out that even though these games were *not* designed as diagnostic visual tests, the teacher should be alert to the students who have problems mastering some of the visual skills. Further observations by a trained individual may lead to the diagnosis of a learning disability related to eyesight.

TITLE: METABOLISM

GRADE LEVELS: 10th–12th

PURPOSE: To learn the steps of intermediary metabolism of cells in an "enjoyable" manner.

PLAYING TIME: varies; time may be called after one class period

NUMBER OF PLAYERS: 2 to 4

PRICE: free

DEVELOPER: Richard E. Goodman

ORDER FROM: Richard E. Goodman, "The Game of 'Metabolism,'" *The American Biology Teacher*, 34:75–78, 83 (February) 1972.

DESCRIPTION: The game consists of the following teacher-made items: a playing board, a deck of enzyme cards, ten oxygen cards, four sets of disk-shaped playing tokens representing carbon atoms (18 atoms per set and each set of a different color), ATP tokens of three sizes representing one, three, and 10 ATP molecules, NADH tokens (color coded), and FADH tokens (color coded).

The playing board shows the interconnected biochemical pathways of the cell's metabolic processes. Each player starts the game with 18 carbon atoms, two ATP molecules, and nine cards dealt from the combined deck of oxygen and enzyme cards. All players start with a draw from either the draw pile or discard pile. They must end play by discarding a card.

There are three kinds of play: "carbon entry," "enzymatic reaction," and "oxidative phosphorylation." In "carbon entry" a player places the correct number of carbon atoms on any one of the four carbon sources (sucrose, glucose, succinate, or glycerol). In an "enzyme reaction" a player places an enzyme card face-up on the discard pile in order to catalyze a reaction for which he has a substrate as represented by his carbon atoms on the board. If ATP is generated in this reaction, the player gains an ATP molecule. If the reaction requires an ATP, the player must give up one. The same rules apply to NADH or FADH molecules. "Oxidative Phosphorylation" involves a player in the exchange or NADH or FADH and an oxygen card, for ATP molecules. Players must not accumulate two or more NADH and FADH molecules. If this happens, the player has an "oxygen debt" which must be met before a player may utilize a "carbon entry" or "enzymatic reaction" play.

The object of the game is to use the three types of play to accumulate 50 ATP molecules.

PREPARATION: The gameboard, enzyme cards, oxygen cards, carbon tokens, ATP tokens, NADH tokens, and FADH tokens must be made before play begins. Many teachers may find that making the playing materials can be an excellent learning experience for students.

Rules must be discussed thoroughly. Even though the rules seem complex at first, they are much clearer to students after an initial attempt at playing the game.

COMMENTS: This game is an excellent way to understand how all the intermediary metabolism pathways join together to provide the cell with energy.

Many teachers think that the use of all the specific names of the enzymes involved in the metabolic processes is above the average tenth grader. In this case, the teacher should only emphasize the major substrates, processes, and products. For more advanced students, the teacher may want to emphasize the total metabolic process, including all substrates.

TITLE: THE MOUSE IN THE MAZE

GRADE LEVELS: 7th–12th

PURPOSE: To help students develop their ability to conduct scientific inquiries and to study learning behavior of laboratory animals in T-mazes.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: individuals or teams of investigators

PRICE: $11.52

DEVELOPER: Victor M. Showalter

ORDER FROM: Houghton Mifflin Company, One Beacon Street, Boston, Massachusetts 02107

DESCRIPTION: The game includes a die, three types of simulator cards, and data cards. There are three variables represented by the simulator cards: species of animal (green), difficulty of maze (orange), and the trial number (blue). The data cards have information (numbers) placed at certain locations on the card. The numbers represent the time to run the maze or the mistakes made by the animal depending upon which side of the data card is used.

To play the game the student devises a question that he wants to answer. An example might be "Can hamsters learn to run a maze faster than mice?" The player then chooses the appropriate animal card(s), maze complexity card(s), and trial number card(s). The student selects one side of the data card representing "Time to run maze" or "Mistakes Made" and rolls the die to determine which one of the six data cards is used. The player places all three punched cards on top of the data sheet and reads off the one number showing through the hole in the stack of cards. The above procedure is repeated as often as necessary to answer the question. The die is rolled each time to determine a new data card. The results are tabulated and graphed.

PREPARATION: All the materials for playing the game are included in the game kit. The rules are clearly written and will require little time to review with the class. A pre- or post-discussion of mazes should be conducted. The author suggests that students design and solve simple pencil mazes as an introductory activity.

COMMENTS: The game is designed to incorporate many of the process skills of science. The students make hypotheses, gather data, and

interpret the results. The game's data is based on actual experiments performed in a psychology laboratory. Simulations of trial runs of the various animals should produce realistic results. This should insure that a distorted view of the learning behavior of the laboratory animals is not obtained from playing the game.

TITLE: NEW TOWN

GRADE LEVELS: 7th–12th

PURPOSE: To introduce students to the problems, conflicts, and compromises associated with planning an urban community, while keeping certain environmental and economic realities in perspective.

PLAYING TIME: varies considerably (from 2 to 15 class periods)

NUMBER OF PLAYERS: 2 to 20

PRICE: Family game: $10.00, Ten-student kit: $16.00, Twenty-student kit: $28.00

DEVELOPER: Barry Lawson

ORDER FROM: Harwell Associates, Box 95, Convent Station, New Jersey 07961

DESCRIPTION: The game kit consits of the following items: a playing board, play money, building tokens, dice, deeds for properties, and an instructor's manual.

NEW TOWN is actually five games (exercises) in one. The first two are designed for junior high school players; the first four are appropriate for high school classes; and the fifth exercise is designed for an advanced high school or college class. All exercises deal with environmental or economic aspects of urban development.

The first exercise deals with an introduction to urban planning and, specifically, the NEW TOWN concept. By answering a set of guide questions and participating in a board game, students learn why homes, businesses, and factories are generally located in certain areas of a growing community.

The second exercise involves an extended version of the first exercise. The players' goal in this game is to build a new community which is a pleasant place to live and work.

The third exercise adds a Town Council to the game. Students learn how local politics affect where public facilities and private buildings are built.

In the fourth exercise, students learn about the duties of a town planner and they see how the planner studies long-range problems in order to find a solution.

The last exercise incorporates several modifications of the previous exercises. These include: a proposed zoning map, an ordinance, bid-

ding for industrial ownership, and environmental laws relating to quality.

PREPARATION: All materials for playing this game are included in the game kit. It is suggested that teachers spend a short period of time to review the game and all of its parts. This should not take long since the directions are concise and clearly written.

COMMENTS: **NEW TOWN** is a well developed board game that simulates many of the economic-environmental problems associated with urban planning and development. Students must utilize knowledge of these problems in order to make money and win points, while at the same time protecting the environment from economic growth and pollution.

The game is highly flexible in time limits and material included in each exercise. Succeeding exercises add a new dimension of reality to the process of urban planning. Having this type of design enables the game to be used with many different age levels and ability groups.

TITLE: NO DAM ACTION

GRADE LEVELS: 9th–12th

PURPOSE: To provide for the involvement of participants in a study and treatment of water resource-related problems.

PLAYING TIME: 7 to 9 hours divided into 15 to 20 minute modules each day for 4 weeks

NUMBER OF PLAYERS: 20 to 40

PRICE: $115.00

DEVELOPER: unknown

ORDER FROM: Instructional Simulations, Inc., 2147 University Avenue, St. Paul, Minnesota 55114

DESCRIPTION: The game components include: a map, a teacher's guide, 30 participation guides, 30 role descriptions, 12 group profiles, a copy of 120 different quest activities, 14 group activity forms, 4 resource manuals, news release forms, and single copies of various reports and permits used in the game.

The simulation revolves around an area's fight to solve its water-related problems. There are 30 roles represented in the simulation. These people are divided into 12 groups representing business, government, and the environment. Many individuals serve on more than one group. Students begin playing this game by reading their roles and background information. According to their roles and group memberships, a student is assigned quest activities to be researched and solved. These quest activities provide background information for the students.

The players then meet in their groups according to the calendar of events. Each group has a profile sheet which lists its members, purpose and procedure, background and frame of reference, tasks, and problems. The groups discuss the issues and vote on a specific action for each problem. There are 6 major water-related issues and 32 water and land problems discussed in the game. Some of the problems include atomic plant licensing, sanitation, and county growth as it relates to water supply.

PREPARATION: All materials for playing this game are included in the game kit. Many quest activities require additional information which may be found by library research or by contacting public officials. It may be advisable (but not necessary) for teachers to become

acquainted with local officials associated with the water supply, planning commissions, and government. Alerting the librarians to the game format and problems will enhance their ability to provide students with assistance. Teachers might also develop their own bibliographies and classroom libraries in order to assist their students.

COMMENTS: **NO DAM, ACTION** is an extremely well-developed simulation. Each game component is clearly written and easily understood after a thorough reading. In many cases teachers may be overwhelmed by the number of game components, but after reading the teacher's guide, they should see how each part fits into the play of the game.

One of the most positive aspects of this game is its thoroughness of coverage of water-related environmental problems. It seems that all of the major environmental concerns that deal with water in any way have been included in this game.

TITLE: OLD MAID WILDLIFE EDITION

GRADE LEVELS: 3rd–8th

PURPOSE: To provide opportunities for students to become familiar with and learn more about animals and plants of the wildlife community.

PLAYING TIME: 15 to 20 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $1.25

DEVELOPER: not listed

ORDER FROM: National Wildlife Federation, 1412 Sixteenth Street, N. W., Washington, D. C. 20036

DESCRIPTION: Game materials include a deck of 38 cards each with one or more wildlife subjects and their names, one "Old Maid" card, an instruction card and instruction sheet, and information on each of the wildlife subjects included.

To play, all of the cards are dealt to the players and pairs of like cards are discarded by each player. The dealer then lets the player to his left choose one card (face down) from his hand and if this results in another pair, that pair is discarded. The player to the left then offers the next player a chance to draw a card from his hand, and this continues until one player is left with the "Old Maid." This player is the loser.

PREPARATION: No preparation is required to play the game but the wildlife subjects included on the cards provide excellent topics for discussion and the teacher may want to initiate and encourage this.

COMMENTS: This game could serve as the point of departure for numerous classroom activities.

Fifteen to twenty minutes is required for each game but it can be played over and over.

TITLE: **PEER PRESSURE**

GRADE LEVELS: 6th–10th

PURPOSE: To help students become aware of peer pressure as a factor in smoking, using drugs, or any other behavior in which group pressure exists.

PLAYING TIME: 30 minutes

NUMBER OF PLAYERS: groups of 6 to 8

PRICE: $5.95 for HEALTH GAMES STUDENTS PLAY

DEVELOPER: Ruth Engs, Eugene Barnes, and Molly Wantz

ORDER FROM: Published in: HEALTH GAMES STUDENTS PLAY, Kendall/Hunt Publishing Company, 2460 Kerper Boulevard, Dubuque, Iowa 52001

DESCRIPTION: This game requires a minimum amount of materials. Required are two sets of slips of paper. On one set the following sentence is written: "Do not take or eat a piece of candy. Resist all efforts of anyone attempting to make you eat candy." The other slips of paper say, "Eat a piece of candy and coerce anyone not eating candy to do so."

The teacher places jelly beans in the center of a group of students. The students have already been given the above slips of paper. The teacher allows the interaction among students to go on for approximately ten minutes. It is also suggested that even the teacher try to coerce students into eating candy.

A discussion period follows in which the groups are asked questions about their thoughts and feelings. The students should be given an opportunity to vent all the feelings of anxiety or hostility that developed during the experience. The teacher should relate this experience to the peer pressure on an individual that develops in school groups to conform to harmful habits such as smoking, drinking, or using drugs.

PREPARATION: The teacher would need to buy a sack of jelly beans and make the slips of papers informing students of their roles. The authors also suggest that rock music, candles, incense, and dim lights might be used during this experience.

COMMENTS: This game is a simple exercise that teaches an important awareness lesson about peer pressure. The exercise is more effec-

tive if the teacher becomes actively involved in coercing the students into eating the candy. It is important that all persons vent their feelings in the discussion sessions (particularly those who do not get to eat the candy).

TITLE: THE PLANET MANAGEMENT GAME

GRADE LEVELS: 7th–12th

PURPOSE: To help students understand contemporary problems like pollution, famines, and the population explosion.

PLAYING TIME: 2 class p

NUMBER OF PLAYI 2 to

PRICE: $22.00

DEVELOPER: Victor M. Showalter

ORDER FROM: Houghton Mifflin Company, One Beacon Street, Boston, Massachusetts 02107

DESCRIPTION: The game kit consists of the following: 5 sets of perforated project cards, 5 project guide cards, a planetary status ledger, 4 overhead transparencies, and a rules and data booklet.

Players become planet managers for Clarion, an imaginary planet. They spend the limited improvement budget for the planet on various projects. There are five separate groups of projects from which to choose. Each round (representing five Clarion years) is allotted 10 bux for its improvement budget. The players choose the various projects from the five groups and the amount to spend on each. They may not choose more than one project from any one group during a round or spend over 10 bux collectively on all projects.

After making their decisions, players take the perforated project cards and the data sheets and determine how the selected projects and expenditures affected the population, food supply, income index, and environmental index for the planet Clarion. The students repeat the above procedure for 10 rounds (or 50 Clarion years). The object of the game is to get Clarion to the most desirable status at the end of the game. The students should actively debate who was the most successful manager.

PREPARATION: All materials for playing the game are included in the game kit. The author recommends that the students be shown how to manipulate the game components. He suggests that students not be told of the "chance" factors built into the game to parallel real life uncertainty. The students should discover the element of chance during play.

comes of the various projects are ones that would be expected to occur on Earth. There is a chance factor built into the game data. Not all projects reap the benefits expected. This game provides an opportunity for students to see that their lives are affected by a variety of factors. Students also see that projects affect their living conditions in a variety of ways.

One of the most important parts of the game involves the discussion at the end. The students critically analyze each other's success at managing the planet. The decision of the winner of the game rests with this analysis. It is during this discussion that a student's values concerning the environment are stated, challenged, and perhaps changed.

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TITLE: **POLLUTION**

GRADE LEVELS: 5th–12th

PURPOSE: To elicit and motivate discussion on some of the issues involved with pollution.

PLAYING TIME: 1 hour or less

NUMBER OF PLAYERS: 8 to 22

PRICE: $30.00 plus $1.50 shipping/handling

DEVELOPER: Ron Faber and Judith Platt

ORDER FROM: Games Central, ABT Associates, Inc., 55 Wheeler Street, Cambridge, Massachusetts 02138

DESCRIPTION: The **POLLUTION** game includes the following components: 24 program sheets, 48 program cards, 3 pollution indicators, deck of chance cards, play money, pollution tokens, one tear-resistant washable game board, and one teacher's manual.

Students are assigned the roles of factory owners and community councilmen from adjacent towns. The towns are confronted with the problems of increasing air, noise, and water pollution levels. The town members have to decide whether or not to purchase a pollution control program for each of the pollution problems. They must also decide who will pay for the programs. There are four different programs for each pollution problem; the better the pollution program, the more money it costs.

There are a total of four rounds played in this game. At the beginning of each round, the town groups receive money and pollution tokens. During the round a town decides upon the pollution programs it wants to purchase and who will pay for them. A chance card is drawn for each town and its directions are followed. At the end of each round the Pollution Indicator Booklet is consulted to determine what happens at the current levels of each type of pollution. As pollution levels increase, monetary payments (losses) must be paid to the bank. The councilman and factory owner with the most money at the end of the four rounds are declared the winners.

PREPARATION: Before the game begins, players must be assigned to their town groups and be designated as town councilmen or factory owners. The playing board should be spread out to allow students to stand on at least three sides. Chairs are not necessary since the negotiating can be done in a corner of the room.

tions for playing the game are well written and easy to follow. All necessary information is found in the game kit.

The questions addressed and debated in this game include the following: 1) Who should bear the costs of abatement programs or the costs of pollution damage? 2) How much are people willing to sacrifice as individuals in order to eliminate pollution? 3) How do the costs of abatement programs compare with the problems caused by unattended, rising pollution?

The most positive aspect of this game is the interaction the students' experience during the negotiating phase of each round. Since the winners of the game are the individuals with the most money, the players attempt to negotiate for the best pollution control program for the money. Idealistic students must deal with the economic realities of the society.

The teacher's manual also gives a series of questions which may be used during a follow-up discussion.

TITLE: **POLLUTION GAME**

GRADE LEVELS: K–6th

PURPOSE: The following objectives are listed for the **POLLUTION** GAME: 1) become aware of various kinds of pollution, 2) know the problems of pollution, 3) know that there are many sources of pollution and that people are the worst, 4) discover that people have a responsibility for the curbing of pollution, 5) match cards by identification of pollution problems, and 6) assist in the motor development of children by practice in the use of cutting with scissors.

PLAYING TIME: 2 class periods

NUMBER OF PLAYERS: Introductory phase: entire class; Card phase: 2 students

PRICE: $.40

DEVELOPER: Nick Rodes and B. J. Amundson

ORDER FROM: P. A. Schiller and Associates, P. O. Box 307, Chicago, Illinois 60690

DESCRIPTION: The game includes: The objectives, the procedures, a list of further activities, and eight environmental sketches. The procedure calls for the teacher to use thermal masters to duplicate the sketches for distribution to all students. After this is done, the students identify each type of pollution found in the illustrations. The teacher should lead a discussion of each type of pollution which would include its sources, the problems associated with pollution, and the means of stopping it.

After the discussion, the student colors the illustrations. Each illustration is then cut out and mounted on an index card. The students are then divided into groups of two and each pair uses their illustrations as a card deck. The cards are shuffled and dealt face down to the two players. The person who is not the dealer turns his first card face up and places it in the middle of the table. The dealer then turns his first card up and places it in the middle. If the card to be placed in the pile is the same as the one face up on the pile, the player wins that pile of cards and places them at the bottom of his face down pile. If the card to be placed in the pile is not the same as the one face up in the pile, the card is placed face up on top of the pile.The first player to run out of cards loses.

PREPARATION: The **POLLUTION GAME** requires a teacher to run off a duplicated set of environmental sketches to be given to each student.

Teachers are also responsible for providing index cards, scissors, crayons, paste, and duplicating masters (or thermal masters) in order to play this game.

COMMENTS: This game has a very simple format. The amount of information obtained from playing might vary considerably from one class to another. This is brought about because the information provided in the discussions is left entirely to the teacher and students. It would seem that the basic objectives of this game could be easily met.

TITLE: **THE POLLUTION GAME**

GRADE LEVELS: 7th–12th

PURPOSE: To help students realize the complex problems ass with air and water pollution in our contem ry society.

PLAYING TIME: 1 to 2 ho

NUMBER OF PLAYERS: 5

PRICE: $17.32

DEVELOPER: Frederick A. Rasmussen

ORDER FROM: Houghton Mifflin Company, One Beacon Street, Boston, Massachusetts 02107

DESCRIPTION: Game materials include a game board, "Take a Chance" cards (22), "Election Cards," Election Ballots (4), dice (2), and four game cars.

The game board contains a circuit of 26 spaces; 20 are properties to be divided by color to the players—5 each. The other spaces are "Take a Chance" slots; when a player lands there he must draw a card and follow instructions.

When the game begins, each player gets $3,500 and two Election Cards from the banker. Players receive $500 each time they pass start. Players collect rent or fees when other players land on their property and some spaces require "auto tune-ups." The Air Pollution and Water Pollution Indexes are set at the beginning of the game and then change as players land on certain spaces and make certain decisions. If either pollution index reaches the "Lethal Limit," the player or team loses the game.

Recommended utilization has teams of players competing to see which team can maintain the lowest levels of air and water pollution in a given period of time—either one or two hours.

PREPARATION: Little time or effort is required to prepare to play this game. Players must read the rules carefully, particularly the first time, and remember the consequences of certain choices.

Teachers may want to follow up game play with discussions of air and water pollution and the frustration which tends to result from continual and often uncontrollable increases of both.

This game comes close to simulating the real-life dilemma surrounding the air/water pollution quandary in this and other countries. As

mentioned in game literature, students will experience the antagonisms and frustrations of trying to change technology and social behavior. Survival is the primary goal of all players and teams and those that neglect the quality of their environment will not nor survive; only those that [illegible] their situation and do [illegible] about it will survive.

As recommended by designers, the game should be played at least twice for players to gain experience in handling the various situations and making the most of the drive for survival.

Time will vary with experience at playing the game but one to two periods will be sufficient.

TITLE: **THE POLLUTION GAME**

GRADE LEVELS: 7th–12th

PURPOSE: To become aware of the complexities involved in the following questions: "Why do manufacturers pollute?" and "Why aren't our local governments doing more to fight pollution?"

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: specific number varies (28 is ideal)

PRICE: free

DEVELOPER: Leslie Jay Gold

ORDER FROM: Gold, Leslie Jay, "The Pollution Game," *The Science Teacher,* Volume 39 (October) 1972, p. 52–53.

DESCRIPTION: In this simulation game, students assume roles as government officials, manufacturers, workers, and citizens. The government officials contract with manufacturers to build airplanes, which must be constructed from over-sized sheets of construction paper. The manufacturers hire workers to build the planes. The excess paper may be dropped on the floor or carried to a recycling center. The first alternative permits the workers to make planes at a fast pace. The second alternative costs the manufacturer in two ways: the cost charged for recycling and the salaries of the extra workers required to dispose of the waste materials.

The government begins the game with a total of $100,000 for this project. This is used to hire officials and to buy planes. Airplanes are produced during a three-minute work period. Three manufacturers begin the game. Each manufacturer starts with $8,000, eight sheets of paper, scissors, and rulers. Each manufacturer must pay each of his employees $1,000. The cost of each sheet of paper is $1,000 and it costs $1,000 to recycle the scraps from three sheets of paper. The government pays the manufacturers $2,000 for each plane produced.

Manufacturers must produce 16 planes after the first work period, 16 planes after the second work period, and 10 planes for each work period thereafter. After the first work period is completed, the government awards a contract to the manufacturer for the best constructed plane. The other manufacturers and their workers will be out of work. However, the manufacturer who wins the contract will hire additional workers to fulfill his obligation.

A conservation official walks around the room and issues reports to

the community and manufacturers on the pollution level. If the community is dissatisfied with the government's performance, they may call for a new election by having a petition signed by one-third of the class. The new government officials may issue a revised contract.

PREPARATION: The following materials must be furnished by the teacher for this game: scissors, rulers, play money ($100,000), and 8½" × 11" pieces of paper. The rules must be read very carefully to all the participants. Each participant must know what his role involves and his possible alternatives for action.

COMMENTS: This game requires students to become actively involved in a business venture directly related to a democratic way of life. The game shows in specific ways the positive and negative aspects of environmental pollution. Students may realize for the first time that to recycle wastes costs a manufacturer a great deal of money. But the game goes far beyond this simple point. It involves students in the political processes of contracting, negotiating, petitioning, electing, and monitoring.

TITLE: **POPPIN' SWAP**

GRADE LEVELS: 4th–10th

PURPOSE: To assist students in learning more about nutrient information.

PLAYING TIME: 15 to 45 minutes

NUMBER OF PLAYERS: 4 to 7

PRICE: $22.50 for 5 decks

DEVELOPER: not listed

ORDER FROM: The Pillsbury Company, 608 Second Avenue South, Minneapolis, Minnesota 55402

DESCRIPTION: The game is made up of 51 playing cards with 5 cards to represent each of these: protein, calcium, iron, vitamin A, thiamin, riboflavin, niacin, vitamin B_6, and vitamin C (total of 45 cards); 4 bonus cards each depicting food high in two nutrients, and 2 empty calorie cards.

To play, all cards are dealt and sorted in each hand according to nutrient groups—protein, calcium, etc. At the signal from the dealer, all players can start swapping with others in the group for one card at a time, without taking turns. The leader calls out the name of the food to swap. The object of the game is to get sets of three or more of the same nutrients. The bonus card can be used for any of the nutrients listed. Empty Calorie cards carry a penalty so players do not want to end the game holding one.

PREPARATION: No preparation is required to play the game. Some discussion of foods and nutrient value may be helpful both before and after playing.

COMMENTS: An interesting card game, similar to rummy, that students will enjoy playing while learning about nutrition.

TITLE: **POSSUM CREEK VALLEY**

GRADE LEVELS: 7th–12th

PURPOSE: To give students an opportunity to practice some of the principles which professional land managers employ.

PLAYING TIME: 2 to 5 class periods

NUMBER OF PLAYERS: class size (25 to 35)

PRICE: $1.50

DEVELOPER: not listed

ORDER FROM: Southern Forest Institute, One Corporate Square, N. E., Suite 280, Atlanta, Georgia 30329

DESCRIPTION: **POSSUM CREEK VALLEY** is a simulation game dealing with various land management techniques. The game kit contains the following materials: 1) instructions for playing the game plus introductory statements about the valley, 2) a printed transparency showing a map of "Possum Creek Valley," 3) five maps of the valley, each covered with a clear acetate sheet, 4) one clear acetate sheet for master plan notations, and 5) cards listing forest land management principles for each of the five groups.

The game centers around the simulated town of Possum Creek Valley. A class starts the game by dividing into five teams which represent the following land management interests: 1) timber management, 2) recreation management, 3) wildlife management, 4 watershed management, and 5) fire protection. Each team is given a map of Possum Creek Valley covered with a clear acetate sheet, a list of management principles concerning its interest, and an assignment to draw up a land management plan for its interest.

The teams meet separately to discuss their responsibilities to Possum Creek Valley and to devise a management plan. After all the plans are developed, the class meets together to discuss each other's plans. A spokesman for each group explains his group's plan to the class. He also attempts to justify the steps his group has taken. A considerable amount of interaction occurs during this presentation segment of the game.

After all the interests have presented their plans, the leader (teacher) attempts to help the class come to a consensus on a master plan for Possum Creek Valley. When this is accomplished, the simulation is over.

PREPARATION: All of the materials for playing **POSSUM CREEK VALLEY** are provided with the game kit except pens suitable for writing on transparencies and an overhead projector.

The author suggests that younger participants may become more actively involved if a story is built around Possum Creek Valley prior to the beginning of the game. This may give the students a sense of history and importance of the make-believe town. The author also suggests that guest speakers might be utilized to spark the interests of older students to the complexities of certain land management techniques.

COMMENTS: This game stresses the active involvement of each participant. It also emphasizes the utilization of sound land management practices to develop the master plan. The "give and take" session of the simulation is probably one of its strongest parts. During this phase, the students present their plans and defend them to the other students. Thus, they must have rational bases for their plans.

This game also emphasizes the spirit of cooperation. Players are not in competition against one another during the game but are working together to develop a master plan for their area.

TITLE: PREDATOR—THE FOOD CHAIN GAME

GRADE LEVELS: 7th–12th

PURPOSE: To teach the concepts of food chain and food web.

PLAYING TIME: 30 minutes

NUMBER OF PLAYERS: 4 to 40 (6 or fewer is best)

PRICE: $4.00

DEVELOPER: Marie Lowell

ORDER FROM: Ampersand Press, 2603 Grove Street, Oakland, California 94612

DESCRIPTION: **PREDATOR** is a card game that deals with the food relationships found in a temperate zone forest. There are numerous variations that students can play using the same cards, including: PREDATOR (the timed version), PREDATOR (the food chain play-out version), GREEN WORLD, SOLITAIRE, CONCENTRATION, and RUMMY.

In order to play the timed version of PREDATOR, the 40 cards are distributed. The person on the dealer's left starts play by calling for a "showdown" with another player. In a "showdown" a player challenges another to lay down a card as he lays down a card. If one card is "eaten" by the other card, the eaten card is taken by the player holding the card of the organism that is the eater. If neither card is eaten by the other, a "stand-off" results. No one loses his cards. Play continues in this manner until several cards are revealed.

A player may call for a "challenge" rather than a "showdown" if he knows the location of a card that he can take. In a "challenge" a player demands a particular card of another player and shows his card that can "eat" it. If he is correct, he wins the card and is entitled to another turn. If he is incorrect, he has to give his challenging card to the player he challenged. When a player is no longer sure of where a certain card is located, he may call for a "showdown" rather than a "challenge." This will end his turn as soon as the "showdown" is completed.

The player with the most cards at the end of the designated time is the winner.

The rules for playing the other versions of **PREDATOR** are found in the rules pamphlet.

PREPARATION: All the equipment for playing **PREDATOR** is included in the game deck; thus, no advance preparation is necessary.

The major decision for the teacher will be to select the version most appropriate for the students. The rules for all five games are uncomplicated and easy to follow. A minimal amount of time would be required to explain the rules and procedures to the students.

COMMENTS: **PREDATOR** is an excellent way of teaching the students the concepts of "food chain" and "food web." It is possible for a student to play this game for five periods without repeating the same version. This offers a great deal of flexibility for a minimal amount of money.

TITLE: RE-CON

GRADE LEVELS: 7th–12th

PURPOSE: To involve participants in environmental decision-making through a role playing episode.

PLAYING TIME: 1 to 2 class periods

NUMBER OF PLAYERS: 14 to 35

PRICE: ERIC charge

DEVELOPER: Pennsylvania State Department of Education

ORDER FROM: ED 081 595, ERIC Information Analysis Center for Science, Mathematics, and Environmental Education, The Ohio State University, 1200 Chambers Road, Third Floor, Columbus, Ohio 43210

DESCRIPTION: Materials for this game include a "scenario," role cards, and voting sheets for each student. Class copies of these materials must be duplicated by the teacher. A large map of the Penn City area must be constructed, but instructions are provided.

To begin play, roles are assigned and each student is given time to read the scenario and role description. (Or two students may be assigned to each role with one being "staff.") Play then proceeds as directed in game instructions.

In this case, Penn City is a depressed coal mining community that needs new industry. Two companies are interested in locating in the area but both want the exact same location. Both have strong points and weak points (pollution, natural resource use, and the like) and the community must decide which industry they want. The roles include a mayor, presidents of the two companies, civic leaders, local businessmen and town officials, and others.

Winners are those who vote for the company that is invited to settle in the community.

PREPARATION: No prior preparation of participants is required.

COMMENTS: A role playing game that, if played seriously, will involve students in a variety of "real" situations that require ample thought and analysis and some tough decisions.

Two class periods should be ample time to play the game and have follow-up discussions.

TITLE: RECYCLE

GRADE LEVELS: 4th–6th

PURPOSE: To teach students the various items that can be recycled and the ways recycling works.

PLAYING TIME: 30 to 45 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: unknown

DEVELOPER: American Association for the Advancement of Science

ORDER FROM: Science— A Process Approach II (Module 88), Ginn and Company, 191 Spring Street, Lexington, Massachusetts 02173

DESCRIPTION: This game consists of a deck of 24 cards with information on both sides. Eighteen of the cards have one side with an item to be recycled and the other side containing a way to recycle items. Three of the cards contain two sides with ways of recycling while the last three cards contain two sides with items for recycling.

The game is played similar to Dominoes. Each player is dealt a hand of five cards. The remaining cards are placed face down in a stack except for the top card which is turned face up. A player places a picture of an item beside the way to recycle. For instance, a picture of leaves is placed next to a card that says "compost pile."

When a player does not have a card to play from his hand, he must draw a card from the deck of remaining cards. The first player to get rid of all his cards is the winner. If all the remaining deck has been drawn and a player can no longer play a card, the player with the fewest cards wins.

PREPARATION: The deck of cards is complete in the game kit. The cards must be cut apart before play is begun.

An introduction to the concept of recycling is appropriate before the game is played.

COMMENTS: The game accomplishes its objective. It familiarizes students with the items that can be recycled and the ways in which these items may be recycled.

This game may be played within a 45 minute period or less.

TITLE: THE REDWOOD CONTROVERSY

GRADE LEVELS: 7th–12th

PURPOSE: To help students clarify and understand the issues and problems encountered in environmental planning.

PLAYING TIME: minimum of two periods

NUMBER OF PLAYERS: 21 plus

PRICE: $13.92

DEVELOPER: Frederick A. Rasmussen

ORDER FROM: Houghton Mifflin Company, One Beacon Street, Boston, Massachusetts 02107

DESCRIPTION: This game is a role-playing simulation of a senate hearing which is considering the establishment of a new Redwood National Park. The students assume the roles of the 15 senators and 6 witnesses. Each senator tries to represent his voters, vote on the merits of the testimony of the witnesses, and get reelected. The witnesses are experts with various backgrounds and occupations; half of them are in favor of a large national park and half are opposed.

During the simulation, each witness testifies for five minutes before the senate committee, after which the senators are permitted to ask questions. When all the witnesses have testified, the senators are asked for a preliminary vote. They have four choices: vote for a small, medium, or large park or vote for no park at all. Then, a fifteen minute recess is called, during which the senators try to get each other to change their votes. At the end of the recess, each senator votes again. The proposal that receives two-thirds of the votes wins.

PREPARATION: All the materials for playing the game are included. A teacher would want to arrange the classroom to look like a senate hearing room. An overhead projector is also helpful in recording and displaying the senate vote.

Outside sources which might enhance this simulation are *The Redwoods* by Kramer Adams (Popular Library Inc., New York) and the Sierra Club film entitled, *The Redwoods.*

Most teachers take a class period to assign the roles and describe the general format of the simulation. The introduction is very important; students must develop an attitude conducive to the success of the simulation.

COMMENTS: This simulation is an excellent way to introduce students to the complexities of environmental planning. It helps students to see that there are a number of variables that must be considered before an environmental decision can be made. The game gets all participants involved in the debating of the issues and the decision-making process. It also helps them realize the pressures put on political figures by a variety of sources. The students should finish this game with a deeper understanding of environmental decision-making and the political process.

TITLE: A SIMULATION GAME ON NATURAL SELECTION

GRADE LEVELS: 9th–12th

PURPOSE: To assist the student in developing the concept that the environment is a selective factor in evolution.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: played with pairs of students

PRICE: free

DEVELOPER: David Kuhn

ORDER FROM: Instructions may be found in *The Science Teacher,* Vol. 36, No. 1, (January) 1969, p. 68.

DESCRIPTION: Two woodland scenes are simulated—one spring and one autumn—in some type of cardboard box, terrarium, or other suitable container. The two scenes must be identical except for color characteristic of the two seasons.

"Insects" represented by small colored cutouts, models, or toothpicks are placed by one partner throughout the simulated environments. The other partner acts as a predator for 20 seconds and "captures" as many of the insects as possible. This process is repeated for each environment and for each partner and records are maintained.

PREPARATION: All materials must be secured locally and game devices constructed and assembled, although none of this should be unusually difficult.

The two environments must be constructed using cardboard boxes or other similar containers and the insects must be either constructed or purchased.

COMMENTS: An interesting simulation that should illustrate quite well some aspects and considerations concerning natural selection.

Playing time required is very minimal—only 20 seconds per player—but the simulation can be repeated numerous times to advantage. One class period should be adequate.

TITLE: SMOG—THE AIR POLLUTION GAME

GRADE LEVELS: 10th—12th

PURPOSE: To acquaint the players with some of the complexities with which a local administrator must deal in controlling the quality of the air over his town.

PLAYING TIME: 1 to 3 class periods

NUMBER OF PLAYERS: 2 to 4

PRICE: $11.00

DEVELOPER: not listed

ORDER FROM: Damon/Education Division, 80 Wilson Way, Westwood, Massachusetts 02090

DESCRIPTION: SMOG is a board game in which each player acts as an "Air Quality Manager" for his city. The object of the game is to be the first player to accumulate 2,000 management credits for his city. A player accomplishes this by making decisions about the families and industries in his community that will earn him money, produce a high level of air quality, and win him votes.

The game begins by a player rolling the die twice to determine his initial number of industries and families. He collects taxes on his industries and families and places his token in the circle marked "Zoning Decision." He then decides whether he wants to pay $1,000 for the right to place his own industries and families or permit a fellow player to place them. After each player has done this, a player rolls the die to determine the direction of the wind. Each factory has a smoke plume that pollutes the air around it and the smoke plumes are placed down wind. If a player's families are caught under a smoke plume, the player loses management credit. Thus, one player's smoke plumes may pollute another player's families.

The next decision is the Growth Decision. This decision is limited by the rule that each industry must have one but not over two families. After the Growth Decision is made, a player draws an Outrageous Fortune Card. These cards are chance cards that may affect the direction of the wind or the opportunity to bid for federal funds. These cards are drawn after each player's turn. The players continue around the board making decisions about their families and industries that will affect the air quality. For these decisions each player is awarded symbols that stand for air quality and the number of votes. On the "Day of

Reckoning" all players tally their management credits from the number of symbols they have. The time of the "Day of Reckoning" is determined when a player draws the "Day of Reckoning" card from the Outrageous Fortune Cards. Play continues around the board until a player earns 2,000 management credits. This player is declared the winner.

PREPARATION: All the materials for playing the game are included. The teacher must take adequate time to describe the game to the class but the rules are not unusually complicated. Students should be warned that they will be responsible for keeping track of their own score.

COMMENTS: SMOG is a board game that has tackled one of the most difficult environmental problems—the development of a sound pollution abatement program that the taxpayers can afford. The "Air Quality Manager" in this game is responsible for developing an air pollution program which takes into account industrial growth, wastes disposal, automobile emissions, population growth, and political standing. Players quickly learn that even though restricting transportation and industrial expansion is a sound environmental decision, it may be an unwise political move.

TITLE: SPEC-CAT

GRADE LEVELS: 7th–12th

PURPOSE: To acquaint students with the characteristics of botanical specimens and with the categories to which these specimens belong.

PLAYING TIME: 15 to 60 minutes

NUMBER OF PLAYERS: teams of 4; unlimited number of teams

PRICE: ERIC charge

DEVELOPER: Pennsylvania State Department of Education

ORDER FROM: ED 081 595, ERIC Information Analysis Center for Science, Mathematics and Environmental Education, The Ohio State University, 1200 Chambers Road, Third Floor, Columbus, Ohio 43210.

DESCRIPTION: No materials are provided but specific instructions for construction of a Bingo-type game board are included along with a sample board. The recommended board has 30 squares and each square is to be filled in with a plant specimen name and pictures of plants that can be identified in a given local geographical area. More difficult specimens are given specified spaces and the most rare is in the center of the board.

Teams of four are chosen with each player being given a game board (mimeographed). The teams go forth to search for specimens. After a given period of time, all teams report to the classroom or other designated spot to determine success on completing the board.

Points are awarded for the number of location of spaces covered.

PREPARATION: Game boards must be prepared to fit the local area and then duplicated. To be successful, students must know some of the specimens available in the region but no extensive knowledge is necessary.

COMMENTS: An interesting design to encourage students to become more involved in local plant identification. Not only do you have a competitive element but you have numerous avenues for student learning through field study, careful collection, identification, and discussion that results from all of these.

Students do need to talk about collecting specimens and develop ideas of "do's and don'ts" for field work.

15 to 60 minutes or longer will be required depending upon the design of the game board and the vicinity.

TITLE: SUPER SANDWICH

GRADE LEVELS: 4th–12th

PURPOSE: To teach the players the concepts of nutrition and a balanced diet.

PLAYING TIME: 50 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: $12.95 plus $1.50 handling

DEVELOPER: Barry Zaid

ORDER FROM: Teaching Concepts, Inc., 230 Park Avenue, New York, New York 10017

DESCRIPTION: This game consists of a full color board, 4 playing tokens, 2 dice, Fruit Stand cards, Dairy Bar cards, activity cards, snack cards, food cards, 4 score cards, 4 marking crayons, and money tokens.

The object of the game is to concoct the "Super Sandwich." This is done by obtaining foods which provide the Recommended Dietary Allowance (RDA) of protein, calcium, iron, Vitamin A, Vitamin B-complex, and Vitamin C and not contain calories in excess of the Recommended Dietary Allowance. Players obtain foods by going to breakfast, lunch, and dinner and purchasing the foods (if they wish) on which they land. After the food has been purchased, a player records its nutritional value on his score card. A player may also purchase snacks, dairy products, and fruit if he lands on the appropriate squares. The nutritional value of these foods is also recorded on a player's score card.

A player may exceed the RDA in any category except calories. When a player exceeds the maximum RDA in calories, he must go to the GYM to work his excess calories off. A player may also lose calories by drawing an appropriate activity card when landing on an activity square. The first player to reach the RDA for all nutrients, without going over the RDA for calories, is declared the winner.

PREPARATION: All the equipment for playing this game is included in the kit. Basic background information on nutrition for each player is not required although it might add to a player's understanding of the game's rules and objectives.

COMMENTS: After playing **SUPER SANDWICH,** a student should be able to do the following: 1) name the various nutrients which help

to make up a balanced diet, 2) recognize certain foods that are high in these nutrients, 3) recognize certain foods that are high in caloric value, and 4) understand the concepts of balanced diet and nutrition.

After playing this game several times, a player should be able to choose his foods wisely in relation to their nutritional and caloric values. He should also be able to choose his snacks wisely (fruit and dairy products rather than sweets and carbohydrates).

This game is designed to be played within a regular class period.

TITLE: IIS SYSTEMS PAK

GRADE LEVELS: 7th-9th

PURPOSE: To teach the student the general organizational scheme of biological units—cells to tissues, tissues to organs, organs to systems, systems to living things.

PLAYING TIME: 15 minutes

NUMBER OF PLAYERS: 1 or small groups

PRICE: contact publisher

DEVELOPER: Harry Wong, Leonard Bernstein, and Edward Shevick

ORDER FROM: Prentice-Hall, Inc., Englewood Cliffs, New Jersey 07632

DESCRIPTION: This game is really a word puzzle. It consists of a deck of cards. There are a total of eight "cell" cards, eight "tissue" cards, four "organ" cards, 2 "system" cards, one "living thing" card, and twenty-two arrow cards. The players are instructed to lay their cards down on the desk in a particular order. The "cell" cards are placed on the desk first; the "tissue" cards are placed above these; the "organ" cards follow; the two "system" cards are next; and the "living thing" card is at the top. All of the cards are connected by arrows. The student then answers a series of questions about the general organizational pattern of living things. The student should finish this activity knowing that cells are organized into tissues, tissues into organs, and organs into systems.

PREPARATION: All of the cards are included for playing this game. If one does not have a class set of LIFE SCIENCE IDEAS AND INVESTIGATIONS IN SCIENCE by Wong, Bernstein and Shevick, then provisions for giving directions and asking questions must be made. These may be presented orally or mimeographed and distributed to the students.

COMMENTS: SYSTEMS PAK is more a life science puzzle than a game. It may be played by a single individual or a small group of students. Students lay out a word puzzle on the desk in a particular sequence and proceed to answer questions about the puzzle's organization. The activity may be enhanced with class studies of specific examples of cell types, tissues, organs, and organ systems.

Prentice-Hall does recommend that this game be used in conjunction with the IIS program.

TITLE: **TO MARKET, TO MARKET**

GRADE LEVELS: 4th–10th

PURPOSE: To help students learn what is necessary to cultivate and market citrus fruit.

PLAYING TIME: 30 to 50 minutes

NUMBER OF PLAYERS: 3 to 6 (plus a banker)

PRICE: free

DEVELOPER: Ida K. Holzer

ORDER FROM: Consumer Services, Sunkist Growers, Inc., P. O. Box 7888, Valley Annex, Van Nuys, California 91409

DESCRIPTION: Game materials consist of a game board diagram which must be mounted (glued) on suitable board material such as chip-board, poster board, or plywood (approximately 48 × 48 cm); markers each with a picture of one kind of citrus fruit (pictures are provided but must be mounted on suitable markers); a spinner which must also be mounted; play money, which must be copied to have a sufficient amount for the game, and a set of instructions.

To play, each player receives $5,000 from the bank and places his marker on the start space. In turn, each player moves the number of spaces indicated by a spin of the spinner and must follow instructions on the space on which the marker lands. For example, "Severe Frost—Return To Start" requires the player to begin all over; "Severe Freeze —Out Of Game" ends the game for that player.

The player with the most money after reaching "The End" space is the winner.

PREPARATION: No preparation is required to play the game but the teacher will have some work to do to get the game board, markers, and spinner ready for play the first time.

COMMENTS: An interesting game that should be fun for the players. In addition, students will learn a bit about citrus fruit growing and marketing if the teacher will take the time to discuss and research many of the factors and situations which are built into the board.

TITLE: **THE TREE RING KIT**

GRADE LEVELS: 7th–12th.

PURPOSE: To help students learn the basic principles and uses of dendrochronology (the study of tree rings).

PLAYING TIME: variable

NUMBER OF PLAYERS: 1 to 30 (in groups)

PRICE: $1.00 per kit (30 kits for $14.95)

DEVELOPER: not listed

ORDER FROM: Tecolote Press, Inc., P. O. Box 217, Glenwood, New Mexico 88039

DESCRIPTION: **THE TREE RING KIT** is actually an activity rather than a game but because it is well designed and simple, it could be the basis for group competition in exploring and "finding out" about the local environment.

The activity presents core samples "bored" from 7 trees—one living and 6 dead and one of the dead logs (trees) is from a log cabin. The problem is to find out how old the log cabin is, using the 7 core samples.

With help from local foresters, students could easily obtain core samples from local sources and embark upon "finding out" activities of their own, with groups perhaps competing to see who can be the most accurate.

PREPARATION: As presented in **THE TREE RING KIT** packet, no preparation is required. If local innovations are in order, preparation would be required to meet the local demands.

COMMENTS: This is an excellent activity, worth using in a variety of classrooms at a variety of ages.

TITLE: **TRIAL: LEGALIZING MARIJUANA**

GRADE LEVELS: 7th–10th

PURPOSE: To allow students, through individual research, to examine both sides of the issue regarding the legalization of marijuana and to assist students in clarifying and making decisions in regard to marijuana use.

PLAYING TIME: 2 class periods

NUMBER OF PLAYERS: entire class

PRICE: $5.95 for HEALTH GAMES STUDENTS PLAY

DEVELOPER: Ruth Engs, S. Eugene Barnes, and Molly Wantz

ORDER FROM: Published in: HEALTH GAMES STUDENTS PLAY, Kendall/Hunt Publishing Company, 2460 Kerper Boulevard, Dubuque, Iowa 52001

DESCRIPTION: This game is played by assigning or allowing students to volunteer for the following roles: a judge, 3 to 4 defense lawyers, 3 to 4 prosecuting lawyers, expert witnesses for each side (as many as needed), a jury foreman, and the remaining class members become the jury. Each participant researches his own role. The game is a simulation of a trial to decide whether marijuana should be legalized. The trial should be conducted as authentically as possible.

PREPARATION: The teacher may want to provide 1) a bibliographical listing of references for both sides of the issue and 2) information concerning the proper way in which to conduct court proceedings.

COMMENTS: This game has a simple format that might be used with any controversial issue. Teachers may expect their students to research their roles more thoroughly on their own if the students 1) have had previous experience with this format and 2) are of a high ability level. If neither of the above are true, then a teacher should provide materials and references for the students and work closely with each student to insure thoroughly developed roles.

The time will vary from one class to the next depending upon the preparation of the students. It would seem that the game would not last less than 2 class periods and not more than 5 class periods.

TITLE: **VITAMINS**

GRADE LEVELS: 4th–12th

PURPOSE: To teach the students the eleven essential vitamins, their prime sources, and the functions the vitamins perform in the body. The students also learn about the disorders caused by a deficiency of any of these vitamins.

PLAYING TIME: 50 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $8.00

DEVELOPER: Tiff. E. Cook

ORDER FROM: The Lawhead Press, Inc., 900 East State Street, Athens, Ohio 45701

DESCRIPTION: The game consists of 33 green vitamin cards, 33 yellow source cards, 33 white function cards, 22 red disorder cards, a Link Key chart, and a 4-color spinner.

The goal of **VITAMINS** is to make three vitamin chains. A chain is made of one vitamin, one source, and one function. The Link Key chart explains all the possible chains.

The game starts by each player spinning the spinner and drawing the number of vitamin cards shown on the spinner. All link cards are placed face up on the table. Play continues with each player drawing the card of the color shown on the spinner. The game is made more interesting by having Double Draw, Medical Miracle, and Super-Spin cards interspersed throughout the Source and Function cards. These cards increase the chances of winning by giving additional chances to spin, draw more cards, or exchange cards. The Health Hazard cards usually take a particular vitamin card away to correct for a disorder caused by a vitamin deficiency. Play continues until a player makes three vitamin chains. This player is declared the winner.

PREPARATION: All the game parts are furnished in the game kit. Advance introduction of the role of the vitamin may be helpful but is not necessary in order for the student to play the game. By utilizing the information found on the cards and the Link Key chart, students could play the game with no prior knowledge of vitamins.

COMMENTS: The positive aspect of **VITAMINS** is that it teaches the three-fold relationship of the body and the role vitamins play in the

proper functioning of the body. First, the game relates the vitamin to its major source. Secondly, the vitamin is related to its major function in the body. Thirdly, a deficiency of the vitamin is related to a disorder in the body. Thus the three-fold relationship is as follows: vitamin to source to function to disorder.

Students should play VITAMINS several times in order to learn the prime sources and primary functions of vitamins. The more the student has the opportunity to play the game, the more likely he will learn the three-fold relationship mentioned above.

TITLE: CLEAN WATER: THE WATER POLLUTION GAME

GRADE LEVELS: 7th–12th

PURPOSE: "To acquaint the players with some of the complexities with which administrators must deal in controlling water pollution to maintain a normal state of ecological balance in local bodies of water." The game "illustrates the biological effects of different types of pollution in lakes so that the players can learn to deal with the problems of water pollution effectively."

PLAYING TIME: 2 to 4 hours

NUMBER OF PLAYERS: 2 to 4

PRICE: $7.00

DEVELOPER: not listed

ORDER FROM: Damon/Education Division, 80 Wilson Way, Westwood, Massachusetts 02090

DESCRIPTION: A very full but attractive game board has a circuit on the outer edge composed of a series of spaces along which players advance clockwise. Each space contains either a lake organism or game instructions. In the center of the board are four lakes connected in series by rivers and the lakes are to be filled with specified numbers of organisms as the game progresses. Also shown on the board are the communities which surround the lakes and rivers with their potential polluters—industries, farms, and residences.

Other parts of the game are the Abatement Cards for 10 types of pollution, the organism pieces for lake life (bass, sunfish, minnows, copepods, rotifers, bacteria, and amoeba), play money, a die, the Organism Exchange Chart, Overpopulation Chart, Pollution Result Chart, and Sources of Pollution Chart.

The object of the game is to completely stock the lakes and the first player to stock his lake wins the game. Players roll the die to progress around the circuit board and on the way they can land on 1) organism spaces which gives them one of that organism for their lake, 2) Organism Exchange spaces which allow the exchange of extra lake organisms, 3) Bid for Federal Funds spaces (to have a chance to make up to $1,200), or 4) Pollution Triangle spaces. The Pollution Triangles cause trouble unless Abatement Cards have been purchased, for one of the six types (10 sources) of pollution will occur and will result in ecological imbalance in the lake of the owner and the next one

downstream. For example, the bass and sunfish might die with a pollution increase from a certain industry but at the same time amoeba, bacteria, rotifers, and copepods increase.

Players have various but continuous decisions to make concerning their lakes: Do they buy the Abatement Cards, how about taxes, how much to bid, should they exchange some rotifers for a bass, and the like.

PREPARATION: Little time is required to prepare the game board and distribute the materials. It will take a period of time to read carefully and discuss the game organization, procedures, and rules. The game has a logical organization and is based upon sound ecological principles and processes and students who play should be familiar with and have opportunities to discuss these. Students should also be familiar with the food chain being highlighted and all of the animals and their characteristics in the game. Game instructions include a good discussion and point of departure for individual and class analysis.

COMMENTS: A very interesting and cleverly organized game that should be fun and exciting for most students. The game is somewhat complicated and adequate time must be allowed to examine and discuss organization, rules, and procedures but playing the first time will also hasten understanding of the game and all that is involved.

With 4 players, actual game time could require 2 to 4 hours but the time can vary a significant amount. Game orientation—discussion of rules, procedures, and technicalities—will take 30 to 45 minutes. Pre- and follow-up discussions on water pollution, food chains, environmental politics, and other related topics could take several class periods.

TITLE: WILDLIFE LOTTO

GRADE LEVELS: 3rd–8th

PURPOSE: To help students learn the names of and become familiar with 54 wildlife subjects—plants and animals.

PLAYING TIME: 15 to 30 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $2.00

DEVELOPER: not listed

ORDER FROM: National Wildlife Federation, 1412 Sixteenth Street, N. W., Washington, D. C. 20036

DESCRIPTION: The game is very similar to **BINGO.** The 6 game cards contain 9 squares, each with a picture of a wildlife subject and none of the 6 cards contains a duplicate picture. The 54 small cards contain the pictures found on the 6 game cards and are matched to those on the game cards. Material provided with the game gives the common name, scientific name, and information on characteristics, location, and other aspects of interest.

Each player (up to 6) receives a game card. One player acts as "caller" and calls out the name of the subject; the player to "fill-up" all spaces on the card is the winner.

PREPARATION: No preparation time is required to play the game. The teacher will probably want to spend some time discussing the wildlife subjects included.

COMMENTS: A very simple but valuable game. Fifty-four subjects are beautifully illustrated on small and large cards and information is provided on each.

PHYSICAL SCIENCE GAMES

TITLE: BALANCING FORCES

GRADE LEVELS: 4th–6th

PURPOSE: To teach students how to balance forces between two points.

PLAYING TIME: 15 minutes

NUMBER OF PLAYERS: 2

PRICE: unknown

DEVELOPER: American Association for the Advancement of Science

ORDER FROM: Science—A Process Approach II (Module 82, Ginn and Company, 191 Spring Street, Lexington, Massachusetts 02173

DESCRIPTION: One must obtain the following materials from local sources: a piece of cardboard (such as a back of a tablet), a brass paper fastener, 3 rubber bands, one ring (1 to 2 inch diameter), and a marking pencil or pen. The game board must be constructed from the above materials by making a hole at the top of the cardboard and inserting the brass fastener. A small square, circle, and triangle are then drawn near the center of the piece of cardboard. The 3 rubber bands are tied to the ring. One rubber band is then fastened to the brass fastener and the other two are left free.

The object of the game is to get one of the three shapes to show in the hole of the ring. The game is played by each player putting his index finger through one of the loose rubber bands. To move, a player points to the spot where he thinks the rubber band should be moved so that the ring goes over a shape. The other player then moves his index finger with the rubber band to that spot. The player keeps his finger in place until the next player takes a turn. All index fingers must stay on the boards during the game. The player who gets any part of the shape showing in the ring wins a point. The first player to get 2 out of 3 points wins the game.

PREPARATION: Described above.

COMMENTS: This game teaches more than mere facts. It gives the students practice in estimating the relationship between two forces. Their accuracy is determined by their ability to focus the circle over a small figure on the gameboard. It is excellent for giving students a chance to practice "balancing forces."

The game takes a minimum amount of time. After the players become familiar with the idea of balancing forces, the game should not take over 10 minutes to play.

TITLE: **CHEM BINGO**

GRADE LEVELS: 7th–12th

PURPOSE: To assist students in memorizing the chemical symbols for the important elements and ions.

PLAYING TIME: 15 to 60 minutes

NUMBER OF PLAYERS: any number

PRICE: $2.95

DEVELOPER: Robert L. Gang

ORDER FROM: The Teaching Aids Company, 59 Kelsey View Drive, Tooele, Utah 84074

DESCRIPTION: Materials provided are four pads of **CHEM BINGO** sheets with 50 sheets per pad, one call list for elements, one call list for ions, and game instructions.

To play, each player receives a "bingo" sheet and then the leader calls out the element or ion. Students mark their sheet with a pencil to indicate a "hit." The player who first receives a full house of hits vertically, diagonally, or horizontally wins that round.

PREPARATION: No preparation is required.

COMMENTS: A very good game if the objective is to learn the elements and ions. Materials developed are sound and well designed. Bingo sheets, for example, can be used up to eight times by using the markings recommended by the author.

Time will vary with complexity of call list, age of players, and the number of rounds. Time can range from 15 to 60 minutes.

TITLE: CHEM CHEX

GRADE LEVELS: 7th–12th

PURPOSE: To teach the names and formulas of ions, the writing and naming of compound formulas, and the writing and balancing of chemical equations.

PLAYING TIME: 50 to 60 minutes

NUMBER OF PLAYERS: 2 or 2 groups

PRICE: $9.95

DEVELOPER: Robert L. Gang

ORDER FROM: The Teaching Aids Company, 59 Kelsey View Drive, Tooele, Utah 84074

DESCRIPTION: Game equipment and materials include a checkerboard, playing pieces (plastic disks—25 of one color and 25 of another), labels for the playing pieces, chemical formulas chart, and an instruction booklet.

Five separate games are described with instructions for each included. All games use the checkerboard and play proceeds much as in regular checkers with straight moves, jumps, double and triple jumps, and kings. Variations depend on the objectives for the game; i.e., to learn the names and symbols of important ions, elements, radicals, and components; to write and balance formulas; etc.

Scoring is different for the various games but detailed scoring instructions are provided.

PREPARATION: No particular preparation is required to participate in this game but one would want either some rudimentary knowledge or be in a situation where everyone else is also learning.

COMMENTS: **CHEM CHEX** should be a challenging game for 2 students in much the same manner that checkers is an interesting game, and, in addition, there is a lot of information that could be learned as a result of playing any one of the 5 variations.

With 5 game variations, time required for play will necessarily be highly variable. Most activity can be satisfactorily carried out within one class period.

TITLE: CHEM CUBES

GRADE LEVELS: 9th–12th

PURPOSE: To provide opportunities for students to acquire and reinforce the basic skills involved in writing chemical formulas and balancing equations.

PLAYING TIME: 15 to 60 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $6.00

DEVELOPER: Robert L. Gang

ORDER FROM: The Teaching Aids Company, 59 Kelsey View Drive, Tooele, Utah 84074

DESCRIPTION: Materials provided include 1) six wooden cubes with each side representing an ion; thus 18 metal and 18 non-metal ions are available, 2) a plastic shaker cup, 3) a pad of score sheets, and 4) a plastic container to hold all of the above.

Nine games are described in the manual and each uses some of the cubes. Games 1 through 7 are involved with naming ions and compounds and their formulas while games 8 and 9 deal with equations.

To play, players select the game to be played and the correct cubes. They then "shake" the cubes in the plastic shaker and toss them on a flat surface. The ions "showing" on top are the ones to be used and must be named or combined as instructed. Each correct answer is worth one point and each is recorded on the score sheet.

The manual recommends twelve "rounds" per game, each round being a turn for each player.

The winner is the player with the highest point total.

PREPARATION: No preparation is required to play the game.

COMMENTS: An excellent game to help students learn to write and name compounds and to write and balance formulas.

The time will vary with the number of players involved (2 to 6), the particular version being used, and the local rules adapted (number of rounds per game, for example), but 15 to 60 minutes seems to be an adequate range.

TITLE: CHEM-E-Z

GRADE LEVELS: 7th–12th

PURPOSE: To teach the student certain fundamental facts and principles dealing with the language of chemistry, solutions, oxidation-reduction, carbon chemistry, and application of chemical principles.

PLAYING TIME: 50 minutes or less

NUMBER OF PLAYERS: 2 to 6

PRICE: $5.00 or 5 copies for $15.00

DEVELOPER: John H. Woodburn

ORDER FROM: E-Z-Science Games, 9208 LeVelle Drive, Washington, D. C. 20015

DESCRIPTION: The game includes a paper game board suitable for mounting on heavy cardboard, name markers, "owners" markers, dice, and six decks of question cards (one each for language of chemistry, general principles, solutions, oxidation-reduction, carbon chemistry, and application of chemical principles).

The game is played by students rolling the dice and moving their markers the number indicated. Each player takes a question card from the pile and another player reads the question aloud. If the first player answers the question correctly, he scores the number of points indicated on the square and places one of his "space ownership" markers on the space to indicate ownership. If the player fails to answer the question, the correct answer is read and no points are lost or gained. Players return question cards to the bottom of the pile. When a player lands on a space that is owned by another player and fails to answer the question, the owner scores the points indicated on the square. However, if the "visitor" answers the question correctly, he wins the points. The corner spaces are squares that cause the players to either gain or lose the number of points indicated without answering any questions. The player with the highest number of points at the end of the designated time wins.

PREPARATION: The author suggests that the teacher cement, glue, or tape the playing board to a piece of heavy cardboard before play begins. The tetrahedron-shaped name markers and ownership markers also have to be cut out and put together.

COMMENTS: The game provides excellent ways of reviewing certain chemical principles and facts. A teacher may want to design additional question cards or adapt a special set of question cards for slower students.

The game has two important factors that help to insure active involvement of all participants: 1) Another player must read the question to the player who has moved his marker (which helps to insure that all persons will listen to the questions as they are being read and formulate their own answers). 2) By owning the squares a player is motivated to keep track of other students' answers (because incorrect answers can mean points to the player owning the square).

TITLE: CHEM RUMMY

GRADE LEVELS: 10th–12th

PURPOSE: To give students opportunities to learn some of the elements of the periodic table and to learn to derive formulas of the various compounds from those elements.

PLAYING TIME: 30 to 60 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: contact publisher.

DEVELOPER: Joan Gates

ORDER FROM: Addison-Wesley Publishing Company, Menlo Park, California 94025

DESCRIPTION: Materials provided are a deck of 56 cards (the size of regular playing cards) containing the following: 36 element cards with the symbol of one of 27 elements; 16 cards with subscript numbers (2, 3, 4, 6, and 7), a parentheses card, two cards with instructions, and a joker wild card.

Each player is dealt 7 element and number cards to begin play. The first player draws a card from the "pile," then discards one. The play proceeds to the next player and on around the group. The first player to lay down all cards in correct formulas stops play for that hand. Each player computes the formula weight for each compound formed and the total weight is the score for that hand.

Play proceeds until an agreed upon score accumulation is reached.

PREPARATION: No preparation is required in order to play the game.

COMMENTS: This is a very good game for helping students learn elements and formulas and all that is involved in the derivation of formulas.

The game is simple mechanically and game components are all within one deck of cards. The only teacher preparation involves making several additional parentheses cards.

The time can easily be controlled by specifying a total score limitation, number of hands played, or by placing a time limit on playing.

TITLE: **CHEM TRAK**

GRADE LEVELS: 9th–12th

PURPOSE: To provide opportunities for students to learn more about elements, ions, and chemical compounds.

PLAYING TIME: 30 to 50 minutes

NUMBER OF PLAYERS: 2 and up

PRICE: $1.95

DEVELOPER: Robert L. Gang

ORDER FROM: The Teaching Aids Company, 59 Kelsey View Drive, Tooele, Utah 84074

DESCRIPTION: Game materials include a rigid cardboard "racetrack," approximately 28 × 18 cm, and instructions for playing the game. The oval racetrack has symbols for 16 elements and 15 ions; at the left of the oval is an "element" wheel and at the right is an "ion" wheel. On the back of the racetrack card are listed the some 550 possible compounds that could result from the elements and ions listed on the racetrack and the 2 wheels.

As noted on game instructions, the racetrack can be "used as part of a class exercise, as a game in competition against other students, or as an individual tutor."

Used as a game, the track has many possible variations for use with any type of grouping from 2 students to 2 classes of students. Students may 1) simply name (or try) the elements and ions around the track with a point for each correct answer, 2) name the compounds that could be formed from ions and elements on the wheels and track, 3) write formulas and names of compounds, 4) name the acids that could be formed, and 5) name or write various types of reactions.

PREPARATION: No preparation is required other than some knowledge of elements and ions.

COMMENTS: This game is very well designed and constructed. It can be used, as described, by individuals as a type of teaching machine (tutor), by 2 or more students for competition, or for class exercises. The purpose is to learn about elements, ions, and combinations of these and if class objectives include these purposes, the game could be useful.

The time will vary considerably depending on the game (variation) being played and the number of students playing; 30 to 50 minutes should suffice.

TITLE: **CHEMINOES**

GRADE LEVELS: 10th–12th

PURPOSE: To help students become familiar with the principles of chemical formula.

PLAYING TIME: 20 to 50 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $2.00

DEVELOPER: John S. Stoane

ORDER FROM: Chemical Teaching Aids, Letham, Ladybank, Fife KY7 7RN, Scotland

DESCRIPTION: The materials provided consist of a set of 35 domino-like pieces plus instructions for play.

CHEMINOES is based on the traditional game of Dominoes and can be played by up to 6 players. The game is played by matching up the valences of the element or radical on another. The pieces are coded to prevent the joining up of atoms or radicals that will not react. The codes include "stars," "spots," and "bars" and it is not permissible to place together 2 stars, 2 spots, or 2 bars. The formula formed by playing each new piece should be said out loud by the player.

Play ends when one player has used all of his or her pieces or none of the players can play. Each player then adds up the total valences of all of their pieces.

PREPARATION: No preparation is required to play the game although some knowledge of elements, radicals, and compounds is assumed.

COMMENTS: The game will encourage the learning of compounds and valences and should be interesting to students for short periods of time.

TITLE: COMPOUNDS

GRADE LEVELS: 9th–12th

PURPOSE: To assist the student in learning the names and formulas of a number of compounds.

PLAYING TIME: 30 to 60 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $6.00 or 5 copies for $25.00

DEVELOPER: Nelson A. Payne

ORDER FROM: Union Printing Company, Inc., 17 West Washington Street, Athens, Ohio 45701; Damon/Education Division, 80 Wilson Way, Westwood, Massachusetts 02090

DESCRIPTION: Game components include a deck of 80 cards representing 21 elements and 4 jokers (making possible the derivation of at least 113 chemical compounds). Instructions include rules for two different games.

To play, each player is dealt 9 cards with the remaining cards making the draw pack, plus one card turned up to begin the discard pile. Players group the cards in their hands to form as many compounds as possible using as many cards as possible. At each turn, the player draws a card either from the draw pack or discard pile, lays down any "legitimate" compounds, and discards one card from his hand.

Players receive points for the number of cards they lay down in compounds; the first player to lay down all of his cards receives 5 points in addition to the points from his cards. Cards remaining in the players' hands after another player "wins" count against them. A game consists of at least 3 hands.

The player with the most points at the end of 3 hands (or other specified number of hands) wins the game.

The second game described utilizes the same cards as above but varies the number of cards per hand, changes scoring rules, and changes some of the procedures.

PREPARATION: No preparation time is required to play the game.

COMMENTS: A very interesting and challenging game for students who know some formulas and who want to learn more. In addition, it is a competitive game that some will find interesting in much the same manner as RUMMY and other card games.

The game is well planned, well constructed, and the instructions are clear and concise.

Time may vary considerably with the number of players and the number of hands per game but in general it will run 30 to 60 minutes.

TITLE: ELEMENTS

GRADE LEVELS: 7th–12th (advanced 6th)

PURPOSE: To assist in learning about and understanding solids, liquids and gases, metals, non-metals, the rare earth elements, the actinides, and radioactive elements.

PLAYING TIME: varies

NUMBER OF PLAYERS: 2 to 6 (possible for 1 to play)

PRICE: $11.00 or 5 copies for $47.00

DEVELOPER: Paul F. Ploutz

ORDER FROM: Union Printing Company, Inc., 17 West Washington Street, Athens, Ohio 45701; Damon/Educational Division, 80 Wilson Way, Westwood, Massachusetts 02090

DESCRIPTION: Materials include a game board, 105 color-coded circular chips, and directions for 4 games and their variations. The game board is a periodic table and the chips represent the known elements color coded to represent generally 5 groups: non-metals, light metals, heavy metals, the actinide series, and the rare earths.

Of the 4 games described in the directions, 3 involve recognizing "chips" and placing them on "spaces" on the periodic table game board. Chips have symbols on one side and names on the other side and the games require identification of symbols and names and/or placement in groups. Game 4 requires the categorization of elements as solid, liquid, or gas and whether or not they are radioactive. Variations for the games involve the use of time limitations to make choices, the use of teams, and, as mentioned earlier, the use of names in place of symbols and vice-versa.

PREPARATION: Very little preparation required to use the games or variations. To be effective, however, players need to be aware of some of the symbols and element names and they must see the need of learning names and symbols and other information on elements and the periodic table.

COMMENTS: All of these games and variations are interesting and skillfully designed. Rules are clearly stated and not complicated. The games are not difficult mechanically. If goals involve learning the elements, their names and symbols, selected characteristics and grouping, the games could be effective and of instructional value. As mentioned

totally effective.

With the flexibility in game utilization, variation in the numbers of players and significance of player background and knowledge on playing speed, playing time can vary tremendously. Players could play for 15 minutes, a full class period, or conceivably several periods on some of the games and their variations.

TITLE: **FORMULON**

GRADE LEVELS: 7th–12th

PURPOSE: To provide opportunities for students to learn the names of atoms and ions and be able to use them to make up chemical formulas of compounds.

PLAYING TIME: 30 to 50 minutes

NUMBER OF PLAYERS: 2 to 8

PRICE: $4.00

DEVELOPER: John S. Stoane

ORDER FROM: Chemical Teaching Aids, Letham, Ladybank, Fife, KY 7 7RN, Scotland

DESCRIPTION: The **FORMULON** pack of cards consists of 78 cards representing atoms and ions, 20 cards called multipliers (for subscripts), and 2 cards designated as Mendeleev cards. Cards representing metals have yellow borders, non-metals have green borders, inert gases have black borders, positive ions have red corners, and negative ions have blue corners.

Each player is dealt 10 cards, face down. The remaining cards are placed face down in a pile with the top card turned face up and placed alongside. At their turn, players (a) place a correct chemical formula made from cards in their hands on the table, (b) change but not replace a formula already on the table or, (c) pick up a card from the face down pile and discard one from their hands.

The first player to use all of the cards in his or her hand wins that round. Other players total the valence of their cards with the value of the multipliers. The winner of the game, after a specified number of rounds, is the player with the lowest score.

PREPARATION: No particular preparation is required for students or teachers.

COMMENTS: This game will serve the purpose quite well: to give students experience in working with chemical symbols and the formulation of compounds. Instructions are clear, concise, and easily understood.

The variables which control the amount of time required are the number of rounds or hands played. Estimated "reasonable" time is 30 minutes to one class period.

TITLE: THE GAME OF ATOMS/ATOMIC SETBACK/ ATOMIC SOLITAIRE

GRADE LEVELS: 7th–12th

PURPOSE: To learn about the elements in the periodic table and the structure of the periodic table.

PLAYING TIME: 30 to 90 minutes

NUMBER OF PLAYERS: THE GAME OF ATOMS: 2 to 6; ATOMIC SETBACK: 2, 3 or 4; ATOMIC SOLITAIRE: 1

PRICE: $6.25 or 5 copies for $27.80

DEVELOPER: not listed

ORDER FROM: J-Squared Plus One, P O. Box 747, Athens, Ohio 45701

DESCRIPTION: These games may be played with one set of materials. The set consists of a playing board composed of two colorful periodic tables and a set of 79 "element" playing cards with 77 element cards, a card for the lanthanide series, and a card for the actinide series. In addition, information on elements and the periodic table are included with the instructions and on the back of the playing board.

All three games resemble familiar card games. THE GAME OF ATOMS is similar to Rummy. Three cards from any one of the 16 groups on the periodic table form a set which may be placed face up on the table. Each player is dealt 7 cards from the deck of 79. Play begins by a player asking any other player for a certain element card needed to make a set. Play rotates around the group. The first player to reach a point total of 500 (or any agreed upon number) wins the game.

ATOMIC SETBACK is similar to bridge and setback. Play is with only 44 cards and each player is dealt 10 cards with 4 left for the high bidder. Players bid on the basis of "sure" tricks because of high atomic numbers and the highest bidder names trumps (groups of the periodic table) and begins play. Tricks go to the highest number if suit is followed and then with trumps if these are played. Each trick is worth 4 points. The winning team is the first to accumulate 100 points or some other agreed upon total. Rules are also available for 2 and 3 players.

ATOMIC SOLITAIRE is played with 77 cards and the object is to "create" with the cards the periodic table—solitaire style. Play begins with 7 piles of cards on the table, three cards face down and one up in

each. Each group must begin with the first element in that group and proceed on down in order.

The game is "won" if and when the periodic table is complete.

PREPARATION: Practically no preparation is required to get ready to play any of these games except for getting straight the instructions and rules of play.

Students do need to know the correct pronunciation for the various elements and some preparation in this area may be helpful although, if not, these will be learned (with penalty) during game play.

COMMENTS: All three games are interesting and should be fun for junior and senior high school youngsters. The games are well designed and the rules are clear and concise. Students learn about the structure and make-up of the periodic table, about nomenclature, about element names, symbols, pronunciation, atomic weight, and atomic number. The games focus on the periodic table and because of this, students will learn simply by playing.

TITLE: GO VECTOR

GRADE LEVELS: 9th–12th

PURPOSE: To learn more about vectors and factors involved in the determination of resultants and as stated by the author, "to catch as many fish as possible on gas enough to travel 50 km."

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 2 to 4 (or groups)

PRICE: free

DEVELOPER: Larry Jensen

ORDER FROM: Instructions may be found in: *The Science Teacher*, Vol. 41, No. 3, (March) 1974, p. 42–43.

DESCRIPTION: The game's author mentions that GO VECTOR is a variation of the more complex VECTOR NAVIGATION—A GAME FOR PHYSICS described in the April 1971 issue of *The Science Teacher*.

The gameboard created for this game represents a lake with a bay and harbor. Each player has a gameboard and an opponent places, on squares throughout the lake and bay, 25 fish, 3 rocks, 2 whirlpools, and 3 gusts.

Players roll a die to determine the number of spaces that can be moved at a turn. After leaving the harbor, normal play begins and motion in the lake is the resultant of two perpendicular components: one due to wind and one due to the boat.

Play ends when every player has covered 50 km of distance as measured along their resultant and the winner is the one with the most fish.

PREPARATION: The gameboards, fish symbols, rock symbols, whirlpool symbols, and gust symbols must be prepared prior to play the first time.

Little preparation will be required to actually play the game.

COMMENTS: A very interesting and challenging game for the study of vectors. Students should enjoy playing the game numerous times.

TITLE: THE GREAT PERIODIC TABLE RACE

GRADE LEVELS: 7th–12th

PURPOSE: To develop a familiarity with the chemical elements as they are arranged in the periodic table.

PLAYING TIME: 20 to 30 minutes

NUMBER OF PLAYERS: 2, 3 or 4

PRICE: $7.00

DEVELOPER: Richard E. Rodin

ORDER FROM: Science Kit, Inc., 777 East Park Drive, Tonawanda, New York 14150

DESCRIPTION: Materials provided include a poster paper gameboard made of a periodic table, 4 player pieces, 1 deck of discovery cards, a pair of dice, and one instruction sheet.

Each player selects a player piece designated either aluminum, copper, iron, or tin. Players begin with hydrogen (#1) and move the number of spaces (elements) indicated by a roll of the dice. Each time a player lands, the name of the element must be called out. The first person to get his player beyond Uranium wins but there are "pitfalls" along the way arising from the necessity of drawing a "Discovery Card" and being required to do whatever is requested.

PREPARATION: No preparation of game materials is required.

COMMENTS: This game would probably be of most value to a group fairly unfamiliar with elements and the periodic table. Students could play "superficially," simply jumping from space to space paying no attention to the elements and the organization of the table. Care should be taken, however, to discuss with them the table and certain characteristics.

TITLE: IONIC BINGO

GRADE LEVELS: 7th–12th

PURPOSE: To provide opportunities for students to learn the nomenclature of chemistry.

PLAYING TIME: 1 to 4 class periods

NUMBER OF PLAYERS: 4 and up

PRICE: free

DEVELOPER: William Lamb

ORDER FROM: Instructions may be found in *The Science Teacher,* Vol. 42, No. 1 (January) 1975, p. 41–42.

DESCRIPTION: Game materials consist of sets of "bingo" cards with chemical symbols printed in the grid squares, such as SO_4^{-2} or PO_3^{-3}, and a set of call cards. Bingo cards and call cards may include series for anion symbols, anion names, cation symbols, cation names, compound symbols, and compound names.

The game is played as in any other bingo-type activity. *The Science Teacher* article suggests procedures for selecting teams, the number of rounds to play, prizes, and the like and those interested in using this game should refer to that article.

PREPARATION: The bingo cards and call cards must be prepared prior to the first time the game is played and anytime thereafter that the game "difficulty" or thrust needs to be changed.

COMMENTS: A very good game for helping students learn the suggested nomenclature. Students should enjoy playing this game just as much as any other bingo game.

Time required to play the game can be controlled by the teacher but one class period would seem ample.

TITLE: P & S

GRADE LEVELS: 9th–12th

PURPOSE: To provide opportunities for students to become more fa miliar with chemical substances and their chemical and physical prop erties.

PLAYING TIME: 30 to 50 minutes

NUMBER OF PLAYERS: 2 to 8

PRICE: $4.00

DEVELOPER: Alma Armstrong

ORDER FROM: Chemical Teaching Aids, Letham, Ladybank, Fife, KY 7 7RN, Scotland

DESCRIPTION: Materials provided include three types of cards, game instructions, and a small storage box. The three categories of cards are 1) pink substance cards—60—with names of chemical elements or compounds and 10 "New Property Cards," 2) 54 yellow property cards, 3) 8 blue error cards, and 4) 16 blank cards.

Each player is dealt 5 substance cards with the remaining cards placed face down on the table. The top 4 property cards are placed face up on the table and the rest of the pack face down. The error cards are placed so that any player may reach them.

The first player tries to match correctly one of the substance cards in his or her hand to one of the four property cards on the table. For example, the substance card "Hydrogen" could be placed beside the property card "produced by adding dilute hydrochloric acid to a material." If a mistake is detected, an error card may be used and if the challenge is correct, five points are awarded the challenger.

Play continues until one player has played all of the cards in his or her hand. Points are accumulated each time a substance card is played, for errors as mentioned above, and for being the first to lay down all cards.

PREPARATION: No actual preparation is required although some knowledge of properties of substances will be necessary to proceed with the game.

COMMENTS: This game is well designed and should be able to meet the objectives for which it was developed. The teacher may de-

lete cards that are not appropriate for particular classes and, in addition, may make additional cards to supplement those provided.

Time will vary with the number of players and the extent of their knowledge but the time can be controlled easily by limiting or extending the number of hands played. Estimated time is 30 to 50 minutes.

TITLE: AN EXCITING WAY TO EXPLORE THE ATOM

GRADE LEVELS: 7th–12th

PURPOSE: To provide activities which help students understand the structure of the atom and placement of electrons in orbits.

PLAYING TIME: varies; 10 to 30 minutes

NUMBER OF PLAYERS: 12 to 30 plus

PRICE: free

DEVELOPER: Thomas J. Plati

ORDER FROM: Instructions may be found in: "Role Playing: An Exciting Way to Explore the Atom," *The Science Teacher*, Vol. 37, Number 2, (February) 1970, p. 81.

DESCRIPTION: The only preparation required for this activity is to arrange the chairs in the room in a pattern similar to the electron shells or orbits of an atom. Thus, Row 1 has 2 seats, Row 2 has 2 seats, Row 3 has 6 seats, Row 4 has 2 seats, Row 5 has 6 seats, and Row 6 has 10 seats.

As students enter the room, they are told to fill the seats from the front of the room so that "shells" are filled as would be the case with electrons. From this type activity or role play, discussions of various kinds would arise covering electron shells, orbits, or clouds.

COMMENTS: As described in *The Science Teacher* article, this represents another alternative to helping students understand a complicated topic. It could be an excellent means of initiating discussion; many aspects of electron configuration could be explained as they develop from this type of exercise.

TITLE: VECTOR NAVIGATION

GRADE LEVELS: 9th-12th

PURPOSE: To learn to 1) find the resultant position and net displacement of two component vectors and 2) plot the resultant of three vectors graphically as well as algebraically and trigonometrically and 3) appreciate the value and significance of vectors.

PLAYING TIME: 30 to 45 minutes

NUMBER OF PLAYERS: any number up to 40 or 50

PRICE: free

DEVELOPER: Oliver Perry and Reed Campbell

ORDER FROM: Directions and instructions may be obtained from "Vector Navigation—A Game for Physics," *The Science Teacher*, Vol. 38, No. 4, (April) 1971.

DESCRIPTION: Materials include a 10 × 10 grid sheet and player markers. Each player needs one of each.

To start the game everyone is given a grid sheet and places their markers at the starting point. The teacher states the following conditions: direction and speed of navigator; direction and speed of wind; and length of time the navigator will travel before any of the above conditions change. As directions are given each student plots the course on the grid sheet. Gradually, the instructor changes the condition of navigation and students move accordingly.

At first the primary object of the game may be simply to get to the destination; later as students gain proficiency there could be races of a variety of types.

PREPARATION: The grid sheets and markers must be provided and the students must understand the rules of game play and the objectives prior to beginning.

COMMENTS: An interesting game for use in physics or other courses where vectors are given particular emphasis.

The author gives a number of suggestions on how to use the game, variations of game use, and things to look for. Preparation time and materials required are both of minimum levels.

The time required to play the game will necessarily vary with the class but the teacher can also control the time by regulating the number of moves required to get to the destination.

EARTH-SPACE SCIENCE GAMES

TITLE: APOLLO—LUNAR DECISIONS

GRADE LEVELS: 6th–12th

PURPOSE: To provide students with an opportunity to become involved in decision-making.

PLAYING TIME: 30 to 60 minutes

NUMBER OF PLAYERS: groups; 5 to 35

PRICE: free

DEVELOPER: not listed

ORDER FROM: National Aeronautics and Space Administration, 411 East Capital Street, S. E., Washington, D. C. 20003

DESCRIPTION: This game is a situation/simulation activity where a group of "stranded" space travelers crash land 200 miles from the intended landing site and must walk the 200 miles. They can carry only certain items and the group must decide which items will go. Each item must be discussed by the group and then ranked.

Provided is the scenario, the list of items that are available (but from which 15 must be selected), and sheets on which to record group rankings of the various items.

There is no winner, as such, although the teacher could identify the group that has selected a "most sensible" list and provided the most logical rationale.

PREPARATION: No preparation time is required although some discussion of group dynamics may be in order. The teacher will need to make copies of the scenario and tabulation sheets.

COMMENTS: An activity of interest to groups at almost any grade level or age. Intense discussions are likely to result and will provide many opportunities for increased understanding of content as well as group decision-making.

30 to 50 minutes will be required but this may vary significantly with the group size and the level of sophistication of the group.

TITLE: HURRICANE ZETA

GRADE LEVELS: 5th–12th

PURPOSE: To increase understanding of how to react to and what to do in the event of a natural disaster, such as a hurricane.

PLAYING TIME: 45 to 60 minutes

NUMBER OF PLAYERS: 16 to 22 (or more with grouping)

PRICE: free

DEVELOPER: Dorothy A. Moore

ORDER FROM: Your local Civil Defense Preparedness Agency; Request: GAMES THAT TEACH

DESCRIPTION: **HURRICANE ZETA** is a simulation activity dealing with the approach of the hurricane to the city of Richmond, Virginia. Fourteen specific roles are to be assigned plus a number of "citizen" roles which could utilize a grand total of 20 to 30 students.

Materials provided include the "Simulation Story" and brief descriptions of the roles to be assigned such as Fire Chief, Mayor, Radio Announcer, and Electric Company representatives.

The setting utilizes television coverage of descriptions of events—as the storm approaches, during the storm, and the aftermath—and the various roles must describe what is happening and what they plan for their particular areas of concern.

PREPARATION: All participants must be familiar with their roles and the "rules of the game." They need to discuss the types of things which might and often do happen in cities struck by hurricanes and perhaps consult library sources for additional insights.

COMMENTS: This could be an exciting and useful simulation if handled properly. Students must be encouraged to take their roles seriously and think about what they will say "on the air."

Some "props" may be useful, such as microphones, maps of the city, weather maps, and the like.

Preparation time could run several hours; actual "broadcast" time would run 45 to 60 minutes.

TITLE: LUNAR SURFACE—SPACE COMMUNICATION

GRADE LEVELS: 3rd–6th

PURPOSE: To help students learn the concepts and value of accurate observation, recording, and transmission of scientific data.

PLAYING TIME: 30 to 50 minutes

NUMBER OF PLAYERS: 12 to 30

PRICE: free

DEVELOPER: not listed

ORDER FROM: National Aeronautics and Space Administration, 411 East Capital Street, S. E., Washington, D. C. 20003

DESCRIPTION: This is a role play involving astronauts on the moon. Roles involve astronauts, radio transmitter, radio waves, and teams of scientists. Play space requires a moon "crater" "salted" with sets of observable objects and information centers for each team of scientists.

To play, teams of six players are selected and each player is assigned a role—astronaut, scientist, radio wave, or radio transmitter. The astronaut visits the crater and then goes to the transmitter with observations; the transmitter relays the information to the radio wave who takes it to the scientists. The scientists make accurate recordings, charts, graphs, and other techniques to show clearly what their astronaut has found.

When the astronauts have completed their observations, the groups compare notes to see which team made the most accurate findings.

PREPARATION: Discussion of observation, transmission, and recording techniques prior to playing the game would be helpful.

COMMENTS: An enjoyable game for young students to practice collecting and recording data.

Thirty to fifty minutes will be required. The game can be played several times with discussions along a number of lines about space travel and other activity.

TITLE: SAFE-CHECK BOARD GAME

GRADE LEVELS: 2nd–4th

PURPOSE: To teach students the names of natural disasters and to familiarize students with Civil Defense shelter symbols.

PLAYING TIME: 20 to 30 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: free

DEVELOPER: Dorothy A. Moore

ORDER FROM: Your local state Civil Preparedness Agency; request: GAMES THAT TEACH.

DESCRIPTION: Materials include a paper game board and 16 markers—4 for each player. The game board is provided although a larger, more durable one may be desirable and would be easy to construct. The markers must be located (or made) and must be four-of-a-kind so that each player has 4 "men" that are alike.

Players begin with their men on the border of the gameboard and through rotating turns they move each marker toward the Safe Zone, avoiding "natural disasters" and being "jumped" (and thus eliminated from the board) by other men.

PREPARATION: The teacher will need to discuss with students the meaning of the various terms used on the gameboard.

COMMENTS: A very simple game but one that students can learn from and, at the same time, enjoy.

Thirty minutes or less will be required to discuss the terms and 20 to 30 minutes for playing.

TITLE: SPACE HOP

GRADE LEVELS: 5th-12th

PURPOSE: To teach players about the sun and its planets, moons, comets, and asteroids.

PLAYING TIME: 1 to 2 class periods

NUMBER OF PLAYERS: 2 to 4.

PRICE: $12.95 plus $1.50 handling

DEVELOPER: Helmut K. Wimmer

ORDER FROM: Teaching Concepts, Inc., 230 Park Avenue, New York, New York 10017

DESCRIPTION: Materials for **SPACE HOP** include a "universe" game board, Mission cards, Hop cards, SNC cards, dice (2), 4 space craft, and a Space Hop Decoder.

The universe game board has the known planets, the sun, Halley's comet, numerous asteroids, and 6 Space Portals. The board is covered with a grid and space craft move from block to block according to the role of the die. Each player begins the space travel from one of the 6 Space Portals; by drawing a Mission Card they receive instructions for their destination. They move toward their destination by taking turns rolling the dice. If they do not know the location of the planet described on the Mission Card they may refer to the Space Hop Decoder. Upon arrival at their destination planet, the player draws a SNC (Space Navigation Credit) card to determine the number of credits received for successfully completing the mission. The first player to receive 25 SNC credits is declared "Astronavigator" and wins the game.

PREPARATION: Only a few minutes are required to get the materials ready for play and instructions and procedures are not difficult to comprehend.

COMMENTS: An interesting and well designed game for junior and senior high school students. It is fun for students to play and, in the process, they will learn many facts about the universe and space travel.

One class period is required to play the game but there should be time allotted to discuss various aspects of the universe and travel within it.

TITLE: TERRA II—A SPACESHIP EARTH SIMULATION

GRADE LEVELS: 3rd–9th

PURPOSE: To help children understand more clearly concepts concerning the earth, relationships on earth, needs of those living on earth, and the need for cooperative planning and activity.

PLAYING TIME: 8 hours

NUMBER OF PLAYERS: 25

PRICE: $1.50 for issue #71 of *Intercom* and materials are xeroxed

DEVELOPER: Peggy Mastrude

ORDER FROM: *Intercom* #71, 218 East 18th Street, New York, New York 10003

DESCRIPTION: TERRA II is a simulation designed for middle school students to assume roles which require thought and analysis in the solution of problems which arise as the simulation proceeds.

TERRA II is the largest spaceship ever constructed and is designed to be totally self sufficient just like the earth. One hundred humans are aboard and comprise the crew, technicians, shopkeepers, first class passengers, and second class passengers. For the simulation, students are assigned various roles within those categories.

TERRA II leaves earth with no plans ever to return. However, after 300 days out problems develop in one of the life support systems and unexpected disease begins to envelop the ship. They decide they must return to earth but earth does not want them because of the unknown disease. Finally, 4 countries on earth grant permission to land within their boundaries.

Materials for role descriptions, situation descriptions, group discussions and voting, and diagrams of the ship are all included in issue #71 of *Intercom* with permission to xerox or otherwise duplicate as necessary.

PREPARATION: The teacher will need to discuss with the group the game and its intent and build the atmosphere for an exciting game adventure. The group may even want to construct a "spaceship" or simulate certain rooms or compartments inside.

COMMENTS: A very exciting simulation that middle school students will thoroughly enjoy. Not only will they become more familiar with the essential life support requirements (air, water, heat, food, etc.) but

they are placed in roles requiring tough decisions based upon some tough "facts of life."

As with most simulations, the teacher must create the atmosphere for serious pursuit of the simulation intent—not difficult to do but requiring the "serious intent" of the teacher.

Minimum time suggested by game creators is 7½ hours over a period of several weeks. At least this and probably much more will be required if the class actually does "get into the spirit" of the game.

GENERAL SCIENCE GAMES

TITLE: BULLSEYE PUZZLE DEVICE

GRADE LEVELS: 4th–12th

PURPOSE: To develop logical thought processes by discovering patterns that will solve puzzles.

PLAYING TIME: varies (a time limit may be set)

NUMBER OF PLAYERS: 1

PRICE: $2.10

DEVELOPER: not listed

ORDER FROM: Lawrence Hall of Science, Workshop Room 150, Centennial Drive, University of California, Berkeley, California 94720

DESCRIPTION: This game kit includes the following materials: four pine frame pieces, one masonite base, and 10 masonite square pieces.

The puzzle begins with the bullseye outside of the circle. In order to solve this "brain teaser" the player must move the bullseye to the center of the circle and back again. This can only be accomplished by sliding the blocks from place to place.

PREPARATION: The teacher must assemble this puzzle but the task is relatively easy since all the puzzle pieces are pre-cut. The teacher simply glues the four pieces of the mitered frame around the masonite base and then places the puzzle pieces inside the frame in the correct order, creating the picture of the target with the bullseye on the outside.

COMMENTS: **BULLSEYE PUZZLE DEVICE** is an excellent "brain teaser" type of puzzle. It is easy to assemble and the directions for solving the puzzle are logical and clearly written.

Many students will find this puzzle to be an exciting challenge but others will become frustrated with the puzzle after several minutes and will not complete it. Still others will complete the puzzle by moving the pieces in a haphazard fashion without developing a logical solution.

TITLE: CLASSROOM CHECKERS

GRADE LEVELS: 7th–12th

PURPOSE: To develop skill in solving problems.

PLAYING TIME: varies; 30 to 60 minutes

NUMBER OF PLAYERS: 2

PRICE: free

DEVELOPER: Michael J. Demchik

ORDER FROM: Description and other information from *The Science Teacher*, Vol. 36, Number 9 (December) 1969, p. 74.

DESCRIPTION: Equipment and materials necessary to play this game include a checker board, a set of checkers, scotch tape, and small markers that can be taped on the checkers.

Each player decides on a mystery item or concept which the other is to try to identify (this is the problem to be solved). Each then writes 12 clues related to his or her problem and tapes them to his/her 12 checkers (one clue per checker). The players can arrange the checkers (and clues) in the most strategic positions.

The game progresses as in "normal" checkers but each "captured" checker will yield a clue to aid in solving the problem.

The winner is the first player to "solve" the problem.

PREPARATION: As indicated above, a game of checkers is the basic equipment required; the problems to be solved are created by the players as well as the clues necessary for the "solution" of the problem.

COMMENTS: From *The Science Teacher* article entitled "Classroom Checkers," this game appears to be appropriate for classroom use, effective in bringing about greater understanding of content, and an interesting challenge to the players.

TITLE: COLORS AND PATTERNS

GRADE LEVELS: K–3rd

PURPOSE: To give students opportunities for reinforcement in pattern recognition and problem solving.

PLAYING TIME: 15 to 20 minutes

NUMBER OF PLAYERS: 1

PRICE: $.70

DEVELOPER: not listed

ORDER FROM: Lawrence Hall of Science, Workshop Room 150, Centennial Drive, University of California, Berkeley, California 94720

DESCRIPTION: Materials included in the game packet are a peg-board game board, approximately 13 × 13 cm; 25 golf tees in 5 different colors; two game board holders; and a set of instructions. Prior to playing the first time, the teacher must draw a pattern of some kind on the top of each golf tee.

To play, the student arranges the golf tees in various patterns—vertically, horizontally, and diagonally.

PREPARATION: No preparation is required.

COMMENTS: A very simple, non-competitive activity and/or game for use with young students which should provide the opportunities for reinforcement in pattern recognition and problem solving listed as the purpose.

TITLE: CONFIGURATIONS

GRADE LEVELS: 10th–12th

PURPOSE: To provide opportunities for students to think and reason through interaction with mathematical and geometric puzzles.

PLAYING TIME: 30 to 50 minutes

NUMBER OF PLAYERS: 1 to 10

PRICE: $6.00

DEVELOPER: Harold W. Dorwart

ORDER FROM: Wff 'N Proof, 1111 Maple Avenue, Turtle Creek, Pennsylvania 15145

DESCRIPTION: Materials provided include a pair of red puzzle boards, 8 blue geometric design cards, 3 sets of blue plastic numerals (1–9 and 0), 2 sets of red plastic numerals (1–9 and 0), a detailed instruction booklet, and a plastic storage container approximately 12 × 15 × 2.5 cm.

Game instructions describe 4 separate puzzle activities, each with at least 2 parts. The 4 games or puzzles are: The Fano 7_3, the Mobius-Kantor 8_3, the Pappus 9_3 and other $9_{3\text{-}3}$, and the Desargues 10_3 and other $10_{3\text{-}3}$.

This and other games in the Wff 'N Proof series are difficult to describe in a simple fashion because of the nature of the games and puzzles. The activities are mathematical/geometric and do require thinking, reasoning, and analysis but one must read game instructions for each to understand what is required.

Games can be played by one individual (in competition with self) or with other individuals or groups competing.

PREPARATION: The only preparation required will be reading and understanding game instructions.

COMMENTS: As with most of the games in this series, this one will be a challenge to a certain type of student—highly motivated, intelligent, high achiever in mathematics, and the like. It is a well developed game in design and strategy and would be a valuable addition to materials for individualizing in both mathematics and science classrooms.

The nature of these games allows time to be very much a variable. A student can, for example, work with only one part of a game for 10 minutes or may work with several games for an hour.

TITLE: DECIMETER

GRADE LEVELS: 4th–12th

PURPOSE: To teach the basic units and prefixes of the metric system by requiring students to answer multiple-choice shopping questions.

PLAYING TIME: 40 to 45 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $11.00

DEVELOPER: Paul F. Ploutz

ORDER FROM: The Lawhead Press, Inc., 900 East State Street, Athens, Ohio 45701

DESCRIPTION: The game consists of a gameboard, answer key, 2 dice, 60 colored one-gram cubes, 50 beginning "store" question cards, 50 advanced "shop" question cards, 15 CHANCE cards for beginning players, and 15 CHANCE cards for advanced players.

Players move around a gameboard by throwing the dice and moving the number of spaces indicated. Each colored square represents a particular store. When a player lands on a square, he draws a card from that store and answers the question. The question is a multiple choice question that deals with metric units that are appropriate for that particular store. If the player answers correctly, he is given a centimeter cube to add to his DECIMETER space on the gameboard. The object of the game is to be the first player to collect ten centimeter cubes, thus, filling his DECIMETER space. This player is declared the winner.

Players may also lose cubes by landing on the CHANCE cards. Most of these cards penalize a player for some fictitious situation in which he used the metric system incorrectly or used the English system rather than the metric system.

A separate set of more advanced questions are found on the advanced "shop" cards. The author suggests that beginning and advanced players may play together by using both sets of cards.

PREPARATION: All materials for playing this game are included in the kit.

Students should be introduced to the metric system before playing the game. The introduction should include the three main units of the metric system: the liter, meter, and gram and the main prefixes: milli, centi, deci, deka, and kilo.

COMMENTS: The game has many positive aspects. First, the gameboard is designed to help students answer some of the questions. All lines and spaces are marked in metric units and even the cubes won during the game are one centimeter long and weigh one gram. Secondly, the questions cause students to "think metric" rather than convert from English to metric units. Thirdly, the game is designed so that beginning players and skilled players may play together. The method of scoring is also in metric units.

TITLE: ELEUSIS

GRADE LEVELS: 4th–12th

PURPOSE: To teach the process of inductive reasoning. In doing this the author hopes to have students learn that science laws are "man-made" and changing. He hopes that students will see that the laws are developed from a large number of conclusions based on observations and experiments.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 3 to 9

PRICE: not listed

DEVELOPER: Robert Abbott

ORDER FROM: Martin Groffman, Assistant Principal, Leonardo da Vinci Intermediate School, I. S. 61 Queens, 98-50 Fiftieth Avenue, Corona, New York 11368

DESCRIPTION: ELEUSIS is a card game that uses a standard deck of 52 cards. The object of the game is to get rid of all one's cards by playing them on a center pile. The rule determining which cards are playable is known only by the dealer. A player has a much better chance of winning the game if he is able to figure out the "secret rule" by looking at the sequence of cards already played.

The dealer makes up the rule before the cards are played and writes it on a piece of paper. He then goes through a process called "stripping the deck." This procedure involves removing a small number of cards from the deck to have an even number of cards for each player plus one card. The dealer distributes the cards to every player except himself. The card that is left over after the deal is placed face up in the center of the table.

Players then add cards one at a time to the pile. The dealer declares whether the card is "playable." In order for a card to be "playable," it must correspond to the rule which the dealer has devised. If the card is playable, it remains on the center pile. If the card is not playable, the owner must remove his card from the pile and leave it face up on the table. All of these cards are known as "mistake cards" and may only be played after all of the other cards have been played.

The first player to get rid of all his cards is the winner of the hand and deals next. This player wins points by counting the number of

cards held by the other players. A game ends after each player has dealt twice. The player with the highest score is the winner.

PREPARATION: Since this game is played with a standard deck of cards, the game components may be purchased quite easily in a local store.

A teacher may want to discuss the process of inductive reasoning with the class prior to the start of the game and may also want to discuss the "man-made" nature of science laws and theories and the "changeability" of these ideas.

COMMENTS: This game is designed to get the students involved in the inductive process. After playing **ELEUSIS**, the student should have a better understanding of the true nature of science laws.

TITLE: EQUATIONS

GRADE LEVELS: 2nd–12th

PURPOSE: To provide occasions for students to learn some of the elementary operations of mathematics—addition, subtraction, multiplication, division, and the use of exponents and roots.

PLAYING TIME: 30 minutes and up

NUMBER OF PLAYERS: 2 or more

PRICE: $9.00

DEVELOPER: Layman E. Allen

ORDER FROM: Wff 'N Proof, 1111 Maple Avenue, Turtle Creek, Pennsylvania 15145

DESCRIPTION: Materials provided for **EQUATIONS** include one playing mat, 12 red cubes (imprinted with +, −, 0, 1, 2, and 3), 8 blue cubes (imprinted with ×, ÷, 0, 1, 2, and 3), 6 green cubes (imprinted with −, ×, °, 4, 5, and 6), 6 black cubes (imprinted with +, ÷, √, 7, 8, and 9), an instruction manual, one timer, and a storage box (approximately 15.5 × 12.5 × 2.5 cm).

EQUATIONS may be played at many levels of difficulty, the level being determined by the number of cubes used, the color of the cubes being used, and the extent of understanding of the ideas of the game of the players involved.

The aim in playing is to win by correctly challenging or by being incorrectly challenged by a mathematical situation created by manipulation of the cubes selected for use.

PREPARATION: Little actual preparation time is required but teachers and students will find it necessary to carefully read the instructions prior to beginning play.

COMMENTS: This is another of the well-designed Wff 'N Proof games but cautions are in order for this one. Students must want to play, they must enjoy mathematics, and care must be utilized to select the right variation of the game for the level of understanding of the players.

Thirty minutes is the minimum time for playing if players understand the game. Play could go on for many hours.

TITLE: FUNCTION—ACTION SEQUENCE GAME

GRADE LEVELS: 5th–9th

PURPOSE: To develop an awareness of many necessary considerations when disaster strikes a community.

PLAYING TIME: 15 to 40 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: free

DEVELOPER: Dorothy A. Moore

ORDER FROM: Your local Civil Defense Preparedness Agency, Request: GAMES THAT TEACH.

DESCRIPTION: Materials required include a gameboard with 9 spaces, 54 separate actions of nine community organizations or leadership offices (functions), and instructions for playing the game. To prepare to play the first time, the teacher will need to 1) make 54 "action" cards by copying the numbered action on an index type card and 2) make a durable game board with the 9 spaces included (police, firemen, health officers, superintendent of schools, civil defense official, department of public works, major, department of public welfare, and Red Cross).

To play, the 54 action cards are distributed evenly to the players. The leader indicates the function to begin play and the order thereafter. Each player then puts down a card that describes an action of the designated function and they must play the card with the highest number. The winner of the hand is the player who was able to play the correct action with the highest number; this player takes all the cards from that hand and also serves as leader for the next hand.

The winner of the game is the player with the greatest number of cards won in the various hands.

PREPARATION: The teacher may need to discuss the 9 functions within the community, what they are, and what they would normally do within that community.

COMMENTS: If an objective of instruction is to learn the roles of various community leaders and organizations, this game will be of help.

TITLE: HUEMANIA TIC-TAC-TOE

GRADE LEVELS: 7th–12th

PURPOSE: To provide opportunities for players to experiment with color combinations and experiment with logic.

PLAYING TIME: 20 to 50 minutes

NUMBER OF PLAYERS: 2 to 3

PRICE: $22.50

DEVELOPER: not listed

ORDER FROM: N. Strand, 521 North Marion Street, Oak Park, Illinois 60302

DESCRIPTION: Materials include a walnut-colored wooden box (7" × 7" × 3½") with a light bulb inside. The top of the box is a white translucent square. Three-eighths inch above that is a clear plastic plate. Both the translucent square and clear plastic plate have metal grids on top forming three "alleys." Viewed from the top there are nine squares exactly like a tic-tac-toe playing board. In addition there are 24 square tiles made of "see through" plastic in three colors: 8 blue, 8 yellow, and 8 magenta.

To begin, players place 9 squares on each layer with like colors covering each other. The object is to get "tic-tac-toe" in the combination colors resulting by "mixing" (one over the other) yellow and magneta to get orange, magneta and blue to get purple, and yellow and blue to get green. Each player must choose one of the three combination colors—orange, green, or purple—and can get tic-tac-toe in his color only.

The six square tiles remaining after the initial set-up are divided equally among the players: if 2 players, each receives 3 squares; if 3 players, each receives 2 squares. Players, at their turn, slide a square in one side of one level and catch the square that comes out the other. The next player does the same and play continues from player to player until one achieves tic-tac-toe in his or her color. This results in one point for the player and then play continues. The next tic-tac-toe results in one point for that player and the winner is the player who first accumulates 10 points.

PREPARATION: Very little preparation required. Rules of the game must be understood and agreed upon and players must understand which combination of colors result in the three "game" colors.

COMMENTS: A fun game, challenging to players of all ages. Not much will actually be learned about colors and color combinations (although some) and the extent of logic operable is questionable. As mentioned, though, players will enjoy the game and try hard to figure out a system.

Suggested winner point total is 10 and to achieve this total could require several hours; however, the game can end at any agreed upon time with the winner being the player with the highest point total.

TITLE: HYPOTHESIS

GRADE LEVELS: 7th–12th

PURPOSE: To make it possible for students to experience, in a short period of time, the development of a scientific theory.

PLAYING TIME: varies—1 class period is sufficient for most theories

NUMBER OF PLAYERS: 2

PRICE: $2.50

DEVELOPER: John R. Carlock

ORDER FROM: Tecolote Press, Inc., P. O. Box 217, Glenwood, New Mexico 88039

DESCRIPTION: The game of HYPOTHESIS includes two sets of playing cards; one set is marked "Experiment" and the other "Data." Each set includes 50 cards. Within each set of cards there are 10 cards of each of the following colors: red, orange, green, blue, and black. Each of these subsets are numbered from 1 to 10. The cards are printed so that there is a top and bottom and a right edge and left edge. Thus, the cards give three sets of conditions with which to experiment—number, color, and position.

There are several versions of the game. The "basic game" is played with two players—the scientist and nature. The object of the game is for the scientist to discover the "Law of Nature" which has been written on a slip of paper at the beginning of the game by the person playing nature. The scientist accomplishes this by observing, designing experiments, collecting data, and forming hypotheses from the cards that are played during the game.

There are several "advanced games" that can be played using the same cards. These include cooperative investigation, secretive investigation, and scientific reward. Rules for playing all of the above versions are included with the cards. The more advanced games utilize more players than the basic game.

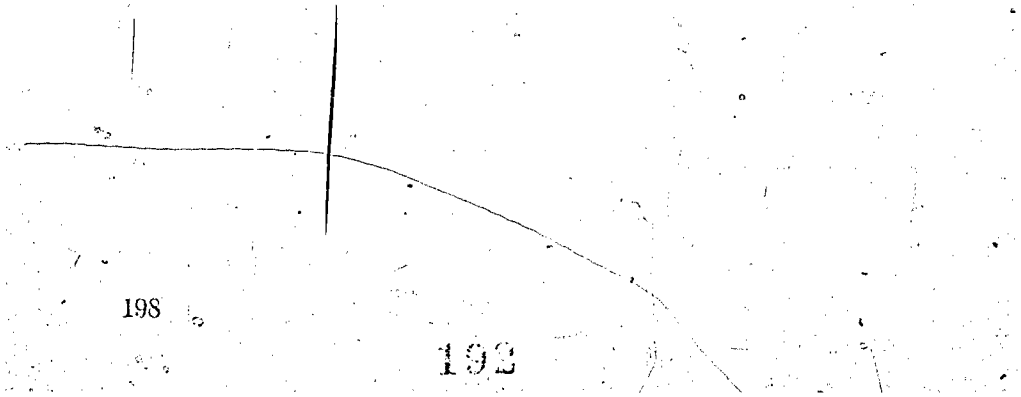
PREPARATION: All the cards and rules are included in the game kit. The author suggests that the students use relatively simple laws to start play. A teacher may want to make a list of possible laws and take the classes through a simple example while explaining the rules.

COMMENTS: This game views science as a set of processes. Students observe, design experiments, collect data, form hypotheses, test

hypotheses, form theories, and accept or reject theories in playing the game.

It is ideal when introducing the scientific method and its various processes. It may be made relatively simple or designed to be extremely complex. Taking the above into account, the game could be used with varying ability levels.

Simple laws and simple versions of HYP[illegible]ESIS require less time than the more complex laws and advance[illegible]ersions of this game. It is possible that a student would be able to complete the basic game in 15 to 20 minutes whereas the more complex laws may take two to three times as long.



TITLE: THE HYPOTHESIS GAME

GRADE LEVELS: 4th–12th

PURPOSE: To teach students how to form hypotheses by making observations of sequences of cards.

PLAYING TIME: 15 to 30 minutes

NUMBER OF PLAYERS: 4 to 6

PRICE: unknown

DEVELOPER: American Association for the Advancement of Science

ORDER FROM: Science—A Process Approach (Module 70), Ginn and Company, 191 Spring Street, Lexington, Massachusetts 02173

DESCRIPTION: This game is played using a deck of regular playing cards. The dealer gives each player six cards and the remaining cards are placed face down. The dealer is responsible for making up a rule for the way the cards are to be played and he writes this rule on a piece of paper.

The dealer draws a card from the deck to start the game. He keeps drawing cards until he finds one that follows the rule and he then places it face up on the deck.

The player to the dealer's left chooses a card from his hand and places it face up on the card just played. He asks the dealer if he may play it. If the card follows the dealer's rule, he is permitted to leave it on the deck. If the card does not follow the rule, it is termed a "mistake card" and is placed in front of the player. In either case the player draws another card from the deck.

The play continues until one player thinks he sees the rule governing the play. At this point the player calls "hypothesis." To check this hypothesis each player takes one additional turn. If the hypothesis is correct, the player who guessed it becomes the dealer. If the hypothesis is not supported, the player who gave the wrong hypothesis misses his next turn. If no one guesses the rule after all the cards have been played, the dealer reveals the rule and takes another turn as dealer.

PREPARATION: The only materials required are a standard deck of playing cards.

An introduction to the process of hypothesizing may be appropriate before a class plays this game.

COMMENTS: This game deals with the process of hypothesizing. It gives the students practice in developing this process and it also emphasizes some of the characteristics of hypothesis. These characteristics include the following: 1) a hypothesis is man-made, 2) a hypothesis is tentative, 3) a hypothesis is supported by human observation, and 4) the more observations a person has to support a hypothesis, the more likely the hypothesis is correct.

The time for playing this game will vary considerably and the degree of difficulty of the rules will be the major cause of time variation. It is certainly possible to play this game within a class period. After the players have had practice in playing the game (hypothesizing), the time for playing will decrease.

TITLE: **HYPOTHESIS MACHINE**

GRADE LEVELS: 7th–12th

PURPOSE: To create situations to assist students in developing skills of careful observation and hypothesis formulation and testing.

PLAYING TIME: 10 to 60 minutes

NUMBER OF PLAYERS: any number

PRICE: $29.95

DEVELOPER: Frank Micciche

ORDER FROM: Educational Materials and Equipment Company, P. O. Box 17, Pelham, New York 10803

DESCRIPTION: Game materials include a plastic frame with 15 tracks (the "machine"), several shapes of obstructions, and 21 lead balls.

To play, the teacher drops the lead balls into the various tracks and students observe. Then they form hypotheses about what happened and about an area of the machine that they cannot see. Each student is given a "work sheet" to indicate their hypotheses about each situation. After students see one "situation," the teacher creates other situations such as placing a wedge in the machine to allow the lead balls to drop into tracks that it seems they should not fall into.

PREPARATION: No preparation is required on the part of students or teachers.

COMMENTS: The **HYPOTHESIS MACHINE** was designed more as a source of classroom activity than a game but can be used as a game with minor adjustments. The apparatus is fascinating and should, indeed, give students practice in observation, hypotheses formulation, and hypotheses testing.

TITLE: IN-QUEST

GRADE LEVELS: 9th–12th

PURPOSE: To provide opportunities for students to become involved in situations which lead to an understanding of and facility in the use of the processes of scientific inquiry.

PLAYING TIME: 30 to 60 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: $6.00

DEVELOPER: Robert Allen, Leo Klopfer, and R. Lawrence Liss

ORDER FROM: International Learning Corporation, 245 South West 32nd Street, Fort Lauderdale, Florida 33315; Wff 'N Proof, 1111 Maple Avenue. Turtle Creek, Pennsylvania 15145

DESCRIPTION: Game materials include 4 error cards, 4 player disks, 40 example cards, one investigation sheet, one theories sheet, one IN-QUEST chart, and an instruction/rule booklet with answers.

IN-QUEST is designed to be played in sections, each dealing with a different area of concern. The 4 sections are 1) Errors in Reporting Observations, 2) Errors in Measurement, 3) Errors in Interpretation, and 4) Examining Evidence.

To play, students decide on the section to begin with; then, using the "Example Cards," predict the error to best describe the situation stated on the card. Each indicates the error selected on the Error Card and on the basis of the answer, receives a point score. The player with the most points after 20 Example Cards is the winner.

Sections C and D are more complicated and require more sophisticated reaction and analysis. Section C requires the use of the Investigation Sheet and Section D requires the use of the Theories Sheet but both still focus on analyzing the data and the implied deductions.

PREPARATION: Students must be familiar with the rules and procedures of game play, preferably by reading carefully game instructions.

COMMENTS: An interesting game that should give participating students experience in thinking—analyzing, reasoning, and making decisions—based on available data. The initial contact with the game may be difficult but once students understand what it is all about, things should proceed quite well. Highly interested, bright students

may well be the most successful types to use the game; the slower, less interested students may not be able to get into the spirit of the game.

Time required can be varied considerably by adjusting the number of example cards used; 30 minutes to a class period should be adequate.

TITLE: LAB APPARATUS

GRADE LEVELS: 4th–12th

PURPOSE: To learn to identify laboratory apparatus; to learn laboratory terminology, the function of various pieces of apparatus, and laboratory safety.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 2 to 6

PRICE: $7.50

DEVELOPER: Paul F. Ploutz

ORDER FROM: Union Printing Company, Inc., 17 West Washington Street, Athens, Ohio 45701

DESCRIPTION: Components include 100 cards with illustrations of apparatus on one side and its name on the reverse; 50 function cards with a question on the function of some aspect of apparatus and the answer on the reverse, 50 safety cards with a question on laboratory safety and the answer on the reverse, and a 3-color spinner. All cards have a point value—either plus or minus.

Players spin the spinner and "land" on white, green, or orange. If they land on white, they draw one of the white apparatus cards and must identify the apparatus illustrated. If they land on green, they must draw a green function card and answer the question or follow the directions, and if they land on orange, they draw an orange safety card and, again, answer the question or otherwise follow directions. For each correct answer players get to keep the cards and the specified points; in some cases they are penalized for poor techniques and/or safety violations. The first player to get 50 points wins the game.

Ten variations of the above game format are suggested in the game booklet and students are encouraged to think of others.

PREPARATION: Very little preparation is required.

COMMENTS: If goals for a classroom include learning 1) the name of laboratory apparatus, 2) some laboratory safety rules, and 3) the purpose or function of some apparatus, then this game should be of value. It is well constructed and durable; directions are easy to follow and until students do learn the apparatus, it will be a challenge.

Time for playing depends to a great extent on the knowledge of apparatus and the number playing but one 50-minute period should be sufficient.

TITLE: MENTAL HEALTH

GRADE LEVELS: 6th–12th

PURPOSE: To help the individual player understand his mental health needs and show him ways of dealing with problems.

PLAYING TIME: 1 class period

NUMBER OF PLAYERS: 2 to 6

PRICE: $8.00 or 5 copies for $34.25

DEVELOPER: Tiff E. Cook and Paul Ploutz

ORDER FROM: The Lawhead Press, Inc., 900 East State Street, Athens, Ohio 45701

DESCRIPTION: This game consists of the following materials: 4 decks of cards (need cards, coping cards, stress cards, and anxiety cards), a spinner, and a pamphlet discussing the rules of the game.

Each player starts the game with the three most basic need cards—physical, security, and love. During the game each player trys to acquire the two additional need cards (self-esteem and self-fulfillment) and the five matching coping cards.

The player with the highest number on the spinner starts the game. He does this by spinning the spinner and selecting the color of the card on which the spinner lands. He may land on need cards, coping cards, stress cards, or anxiety cards. Extra need cards are returned. Coping cards protect need cards from stress and anxiety cards. Unless a student has a coping card, he loses the need card any time he has one stress and one anxiety card which match numbers with the need card. If this happens during the game, a player must return all three cards.

A player may use a coping card to return stress and anxiety cards. In order to win a player must have all five need cards with a matching coping card for each need card. A player must get rid of all anxiety cards but may have extra coping and stress cards when winning.

PREPARATION: All materials for playing this game are included in the game kit.

COMMENTS: This game helps the individual student to become aware of his own basic needs as an individual. It also focuses upon some of the stresses and anxieties which act against the fulfillment of an individual's needs. This game helps students to identify some of the major problems involving their own mental health and ways of dealing with these problems.

TITLE: METER-LITER-GRAM

GRADE LEVELS: 6th–12th

PURPOSE: To help players learn about and learn to use the metric system of measurement.

PLAYING TIME: 30 minutes to several hours

NUMBER OF PLAYERS: 2 to 10

PRICE: $9.00

DEVELOPER: not listed

ORDER FROM: Real-T-Facs, 26 Overlook Drive, P. O. Drawer 449, Warwick, New York 10990, Attention: W. J. Hampton

DESCRIPTION: Game equipment consists of a playing board with the "token" game track being in the shape of a large "M" marked off in centimeter size colored squares through which players must pass as the game progresses, 10 centimeter size cubes each with a different color to match the 10 colors of the squares on the game board, a pair of dice, a deck of "chance" cards, a deck of "examination" cards, and a book of questions and answers with a page of 11 questions and their answers for each of the 10 possible, color-coded players.

To play, players roll the dice and are asked the question with the same number rolled; if they answer correctly, they move forward 6 spaces and if incorrectly, they move backwards 2 spaces. A player landing on his own color draws a "chance" card and must do whatever is instructed; landing on a "multicolored" block requires an examination card and the player must answer either the elementary or advanced question with resulting "space" moves for correct or incorrect responses.

The winner is the first to negotiate all of the blocks (122 in all) on the big "M."

PREPARATION: Very little actual preparation is required to play the game but many of the questions require a thorough knowledge of metric system terminology and conversion factors.

COMMENTS: Played conscientiously, this game will result in increased knowledge of and facility with the metric system, assuming they were not totally knowledgeable to begin with. Included through

the questions and examinations are terminology, symbols, conversion to and from the English system, and structure of the metric system.

The explanation of the rules could be improved but overall the game is sound.

Time will vary considerably because this depends a great deal on the number of players (2 to 10)—from 30 minutes to several hours.

TITLE: METRIC LADDER GAME

GRADE LEVELS: 4th–8th

PURPOSE: To teach students the metric prefixes and the relationships among metric units of measurement.

PLAYING TIME: 10 to 15 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: $7.95 plus shipping

DEVELOPER: not listed

ORDER FROM: Kent Educational Services, P. O. Box 903, Ovicdo, Florida 32765

DESCRIPTION: This game consists of the following: a colorful gameboard, a die, four player markers, and three sets of cards—"Unit Cards," "Mixed Bag Cards," and "Go For Broke Cards."

The game begins with the markers of all the players at the base of the ladder. Each player rolls the die to determine which type of card he draws. Particular numbers on the die correspond to particular cards. The "Mixed Bag Cards" and "Go For Broke Cards" add the aspect of chance to the game. The instructions on these cards must be followed immediately. The "Unit Cards" permit the players to move up the ladder. Each rung of the ladder has ten times the value of the rung below. A player cashes in "Unit Cards" of the exact value in order to move to the next rung. The object of the game is to climb the metric ladder from the millimeter rung (bottom) to the kilometer rung (top). These advances are made by cashing in the proper value of Unit Cards or by following the directions on the "Mixed Bag Cards" or "Go For Broke Cards."

PREPARATION: All materials for playing the **METRIC LADDER GAME** are included in the game package. Many teachers will want to introduce the metric system, especially the prefixes, before their classes begin to play.

COMMENTS: The purpose of this game is to teach the students the common prefixes used in the metric system and how these prefixes relate to each other. The game should accomplish this objective very well.

It is possible to complete this game in a 10 to 15 minute period. This is especially true if a student is already familiar with the prefixes of the metric system.

TITLE: METRICATION

GRADE LEVELS: 7th–12th

PURPOSE: To become familiar with the structure and terminology of the metric system.

PLAYING TIME: 1 hour and 20 minutes (with 4 players)

NUMBER OF PLAYERS: 2 to 4

PRICE: $10.00

DEVELOPER: not listed

ORDER FROM: Metrix Corporation, P. O. Box 19101, Orlando, Florida 32814

DESCRIPTION: Game materials include a playing board. 4 player tokens, a pair of dice, 40 ownership chips (four colors with 10 of each color), 7 denominations of bills (kilo, hecto, deka, meter, deci, and centi), 12 diplomas, and 15 metrication cards.

The playing board is marked off in "chains" of blocks—each block with a "message." Colored blocks may be purchased by the player landing on them and future occupants must pay fines for landing there; white blocks entitle the player to a bonus for landing there and the bonus amounts to the metric sum written on the block; other blocks require the players to do a variety of game moves—for example, charity: collect one Deka from each player; yield sign: remain on this block, losing turns, until another player passes; and school signs: choose whether or not you attend school. There are approximately twelve of this type block plus several optional "trails."

To play, each player receives 10 ownership chips of the same color and nine of each type bill. He begins on the METRICATION block, rolls the dice, and moves his token in the direction of the one-way arrow.

The winner is the first player to increase the basic Metric holdings to at least 10 of each type of bill.

PREPARATION: Very little preparation is required to get ready for this game. The most time required will be to count out 9 of each bill for each player. Players will need to get straight the bill denominations and the relationships of bills to each other.

COMMENTS: Students may simply enjoy playing this game—it is structured similar to Monopoly with enough options and decisions to

make play interesting. If players know that they are supposed to learn about the metric "structure" they should look for it and should learn. It would be possible to play the game, though, without "internalizing" the units or the relationships of one bill to another.

TITLE: MINNEMAST PROPERTY BLOCKS

GRADE LEVELS: K–6th

PURPOSE: To provide opportunities for children to solve problems involving classifying, sorting, describing, and noting the relationships among classes of objects.

PLAING TIME: 10 to 50 minutes

NUMBER OF PLAYERS: 2 to entire class

PRICE: $6.95

DEVELOPER: Alan Humphreys and Jean Dailey (Editors)

ORDER FROM: Minnemath Center, University of Minnesota, 720 Washington Avenue, S. E., Minneapolis, Minnesota 55414

DESCRIPTION: The MINNEMAST set of property blocks contains 48 different pieces. There are four colors: red, yellow, blue, and green; three shapes: circle, triangle, square; two sizes: large and small; and two thicknesses: thick and thin. Each block has 4 distinct properties and is unique in the set. The set also contains an instructional booklet entitled, "Property Blocks—Games and Activities." Several games are described in the booklet. They include the following: Pattern Cards, Shape Bingo, Property Difference, Make Up Rules, Knotty Nots, I Want, Matrix, Rummy, Old Maid, and Matchit. All of these games involve the students in some aspect of classifying, sorting, describing, and noting relationships among the property blocks or facsimiles of the property blocks.

PREPARATION: Only the property blocks are used for games such as: Property Difference, Make Up Rules, Knotty Nots, and I Want. For these games no advance preparation is necessary. However, for other games such as Pattern Cards, Shape Bingo, Matrix, and Rummy, the teacher would be required to make certain types of cards. The directions for making these are given in the booklet.

COMMENTS: MINNEMAST property blocks are colorful and durable. The activities designed to accompany the blocks give students practice in recognizing the likenesses and differences of a set of objects. They also emphasize the processes of problem solving, classifying, and sorting. Experience with these materials may lead students to utilize some of the problem-solving skills to solve more abstract problems.

Some of the games, such as Property Difference and Make Up Rules, require from 5 to 10 minutes to complete. Others, that are more involved, require a much longer time period. All of the games are designed so that they could be completed within a 45 to 50 minute time period.

TITLE: **ON-SETS**

GRADE LEVELS: 10th–12th

PURPOSE: To teach some of the basic ideas [illegible] game for thinkers."

PLAYING TIME: 30 minutes and up

NUMBER OF PLAYERS: 2 to 8

PRICE: $9.00

DEVELOPER: Layman E. Allen, Peter Kugel, and Martin F. Owens

ORDER FROM: Wff'N Proof, 1111 Maple Avenue, Turtle Creek, Pennsylvania 15145

DESCRIPTION: Materials provided for the game include 16 color cards, 2 playing mats, 8 color cubes (each imprinted with blue, red, green, and orange dots), 4 red symbol cubes (each imprinted with the symbols U, ∩, −, and /), 3 blue symbol cubes (each imprinted with ∨, ∧, ⊂, and =), 3 numeral cubes (each imprinted with 1, 2, 3, 4, and 5), an instruction manual, one "hourglass" timer, and a plastic box approximately 15.5 × 12.5 × 2.5 cm.

Many games can be played with **ON-SETS** and can involve as few as two players or "as many players as can comfortably gather around the table to see the cards and cubes." **ON-SETS** may be played at many levels of difficulty with the level being determined by the cubes used, the number of cards in the Universe, the rules, and how well the players understand the ideas in the game. There is the Basic **ON-SETS** game, the Advanced **ON-SETS** game, plus a programmed series of 28 simpler games.

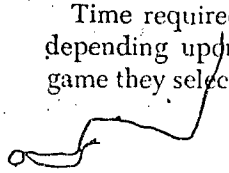
The aim in playing is to win by correctly challenging or by being challenged incorrectly in regard to mathematical "situations" created through manipulation of the various game points.

PREPARATION: Little actual preparation to play the game is necessary, for all materials required are provided. Students and the teachers involved must spend some time with the rules, the "theory," and procedures of play in order to be able to play an intelligent game.

COMMENTS: A very well designed and organized game as are the others in the Wff'N Proof series. Motivation on the part of the players

plus understanding of mathematical symbols and concepts is a must to play this game successfully.

Time required will vary but plan for 30 minutes to several hours, depending upon the skill and understanding of the players and the game they select to play.



TITLE: PIRATE CACHE

GRADE LEVELS: 2nd–12th

PURPOSE: To learn more about graphing and plotting coordinates on a graph.

PLAYING TIME: 50 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: [illegible] for $47.00

DEVELOPER: C. Winston Smith, Jr.

ORDER FROM: The Lawhead Press, Inc., 900 East State Street, Athens, Ohio 45701

DESCRIPTION: Game materials include a game board (marked off in coordinates) with ocean, islands, and underwater reefs; yellow treasure chips, some with a red dot to indicate "pieces of eight;" four player markers; a pair of dice; two captain's "course plotters;" and several "treasure chest" envelope containers.

Two games are described. For Game 1 each player starts at Home Port with a colored token and 10 yellow chips, one of which is marked with a red dot on one side. In order of a roll of the die, players distribute their treasure chips among marked spots on the four islands but keep secret the location of the chip with the red dot. Players then chart their courses to retrieve as much treasure as possible and roll the die to see if they sail the "desired course" or the "off course." In either case they move along two axis, X and Y, and may take several turns to reach their destination. In the process they could hit a reef or endure other hazards that could sink or require them to return to Home Port for repairs. The first player with 20 coins wins.

Game 2 is more difficult than Game 1 but played the same except that each player makes a treasure map of placement of his or her coins and keeps it secret. Players move to the various spots on the islands not knowing if hidden treasure is there until they arrive. A winner is determined the same as in Game 1.

PREPARATION: Players must spend some time reading and discussing the rules of play; otherwise, it could be confusing at first.

COMMENTS: An interesting, challenging game that will cause students to learn about plotting coordinates on a map. The rules and

game descriptions are concise and clear but students do need to spend some time reading and discussing the game purposes, strategies, and rules prior to beginning.

Playing time will vary with the number of players and their experience playing but 50 minutes is the estimated average time.

TITLE: QUERIES 'N THEORIES

GRADE LEVELS: 7th–12th

PURPOSE: To learn the scientific method of inquiry and gain skill in organizing, analyzing, and synthesizing data while engaged in a game of linguistics.

PLAYING TIME: varies according to language developed

NUMBER OF PLAYERS: 2 to 4

PRICE: $12.00

DEVELOPER: Layman E. Allen, Peter Kugel, and Joan Ross

ORDER FROM: Wff 'N Proof, 1111 Maple Avenue, Turtle Creek, Pennsylvania 15145

DESCRIPTION: QUERIES 'N THEORIES is composed of the following materials: 2 Native Mats, 9 Query Mats, 1 Payoff Mat, 1 Query Marker, 1 Instruction Manual, 1 timer, 80 each of blue, green, red, and yellow chips, 40 purple chips, and 120 white chips.

This game is designed to develop the basic skill of asking good questions. Players try to detect the properties of a generative language that one of the players (the Native) has secretly defined by building a set of basic sentences and replacement rules. In the game, the Native's opponents aim to construct good Queries. In order to do so, they must become good Theorists—skillful in organizing, analyzing, and synthesizing data. These processes of formulating Theories and testing them by constructing Queries are deliberately parallel to the methods used in science to probe the laws of nature.

PREPARATION: All materials for playing QUERIES 'N THEORIES are included in the nicely packaged game kit. The game kit is packaged so as to be placed on a bookshelf.

COMMENTS: Many science educators emphasize the importance of the science processes in a student's education. This is a relatively sophisticated game that challenges the student to utilize the processes surrounding the scientific method.

The game is well developed with many rules guiding the play of the game. However, the game's success depends upon the creative reasoning ability of its players to generate a language and use inductive thought processes to detect the properties of that language.

This game is especially challenging for the more advanced student—

one with a highly developed inductive reasoning ability. However, the game could also be used at other ability levels by introducing the options of the game very slowly.

The time required for completing this game will depend upon the players. Their experience with inductive reasoning should shorten playing time and the sophistication of the generative language developed by the Native will also play a part in determining the playing time. If experienced players are dealing with a relatively simple generative language, the game should be completed within a class period.

TITLE: **QWIK-SANE**

GRADE LEVELS: 4th–12th

PURPOSE: To teach students logical thought processes by having them find a pattern of moves that will solve a puzzle.

PLAYING TIME: varies

NUMBER OF PLAYERS: 1

PRICE: $2.00

DEVELOPER: J. R. O'Neil

ORDER FROM: Wff 'N Proof, 1111 Maple Avenue, Turtle Creek, Pennsylvania 15145

DESCRIPTION: This "brain teaser" puzzle includes the following materials: a cardboard tray lined with foam and 13 wooden blocks. The blocks spell out "THINK HARD." There are 4 other blocks—one has a picture of a thinker, one has the number 35, one has the words "QUIK-SANE," and the last has the words "Wff 'N Proof."

The puzzle is "set" by placing all the pieces in a particular pattern. The words THINK HARD are spelled out in the pattern. A blank space is left in the upper right hand corner while the block with the picture of the thinker is in the lower left-hand corner. The object of the puzzle is to move the block with the thinker on it into the blank space without disturbing the rest of the pattern.

PREPARATION: This puzzle is complete and ready to play as soon as one gets the kit.

COMMENTS: **QUIK-SANE** is a puzzle that might be classified as a "brain teaser." This game could be frustrating for a student who has little patience or for a class that has a strict time limit. It is also possible that a student might solve the puzzle without using any logical thought processes. However, many students will find this puzzle an interesting challenge which requires much concentration.

Many teachers will not want to set a specific time limit for this "brain teaser." This puzzle might be placed in a game center to be played with after the student's regular work is completed.

TITLE: **RACEWAY 8**

GRADE LEVELS: 7th–12th

PURPOSE: To enable players to learn [illegible] tively the metric syst[illegible] the skill of estimating.

PLAYING TIME: 40 to 60 minutes

NUMBERS OF PLAYERS: 5 (up to 10 with advanced rules)

PRICE: $6.00

DEVELOPER: Victor Showalter

ORDER FROM: Estimetrics, Box 3138, Columbus, Ohio 43210

DESCRIPTION: Materials provided include a raceway layout that must be glued together and mounted on plywood or other solid material; small racing cars, dice, color block, and complete instructions for game preparation and play.

To play, each player selects a car and places it on one of the racetracks on the board. Then an object (selected by the teacher) is brought out to be measured or weighed by estimation by each player. After recording each estimate, the object is measured or weighed (or the known measurement is recorded) and the players determine how close each player is to the actual measurement; how close determines the number of spaces each car is allowed to move on the board.

The winner is the first car to cross the finish line.

PREPARATION: Very little preparation is required to play the game. As mentioned above, the teacher will need to assemble the racetrack and youngsters may want to paint, color, and otherwise "dress-up" the playing board.

COMMENTS: A well designed game that should accomplish stated objectives.

The time will vary considerably depending upon the objects used for measurement. Time can be called at any point with the car in the lead winning.

TITLE: RIP OF

GRADE LEVELS: 4th-12th

PURPOSE: To enable students to identify and analyze 12 common "appeals" used by advertisers to sell their products.

PLAYING TIME: 45 to 60 minutes

NUMBER OF PLAYERS: 2 to 6

PRICE: $7.50

DEVELOPER: Paul Ploutz

ORDER FROM: Union Printing Company, Inc., 17 West Washington Street, Athens, Ohio 45701

DESCRIPTION: The game consists of the following components: 120 Product cards, 50 Odd-Job cards, 50 Liquidation cards, 1 Table Tent card listing the appeals, and a Key to the Appeals.

Each player is given 5 product cards to start the game. The object of the game is to identify the type of advertising appeal used. If players are successful, they are allowed to discard the product card and draw a liquidation card. The liquidation card has instructions rewarding the player for sound consumer practices or punishing the player for unwise consumer choices.

If the player fails to name the appeal correctly, he is "ripped-off." The player then adds the product card to his hand and draws an Odd-Job card. The Odd-Job cards award or take away money according to the event on the card.

The player who discards all of the product cards first is the winner. The player who has earned the most money is runner-up.

PREPARATION: All the components of the game are included. The teacher may want to use this game as a starting point for a consumer education unit without introducing the various appeals to the students. Thus the students would learn the appeals as they played the game. No advance introduction to advertising would be required in this instance.

Another method for utilizing the game would be to use it as an evaluation tool to see how well students were able to distinguish among the various appeals. This method would call for an introduction to the advertising world before the game is used.

COMMENTS: This game is highly recommended for two reasons. First, the game teaches a student to be a more conscientious consumer.

Secondly, the game teaches a higher order learning process—the skills of analysis. This goes far beyond the mere memorization of facts which is the major objective of many games.

The products and services used in the game are ones that are relevant for the students and their families. Many of the fictitious names and slogans are paraphases of original products and advertisements. This gives the game a humorous note.

Also the author suggests many open-ended activities that can be used as extensions of the game. For example, he asks the students to determine which appeal(s) work best on them so that they might become wiser shoppers.

TITLE: SCI-E-Z

GRADE LEVELS: 7th–12th

PURPOSE: To teach the student certain fundamental facts and principles dealing with elementary physics, astronomy, biology, geology, chemistry, the language of science, and applications of science principles.

PLAYING TIME: 50 minutes or less

NUMBER OF PLAYERS: 2 to 6

PRICE: $5.00 or 5 copies for $15.00

DEVELOPER: John H. Woodburn

ORDER FROM: E-Z Science Games, 9208 LeVelle Drive, Washington, D. C. 20015

DESCRIPTION: The game includes a paper game board suitable for mounting on heavy cardboard, name markers, "owners" markers, dice, and six decks of question cards. There is a deck of question cards for each of the following science areas: elementary physics, astronomy and the language of science, biology, geology, chemistry, and applications of science principles.

The game is played by students rolling the dice and moving their markers the number indicated. Each player takes a question card from the pile and another player reads the question aloud. If the first player answers the question correctly, he scores the number of points indicated on the square. He also places one of his "space ownership" markers on the space to indicate ownership. If the player fails to answer the question, the correct answer is read and no points are lost or gained. Players return question cards to the bottom of the pile. When a player lands on a space that is owned by another player and fails to answer the question, the owner scores the points indicated on the square. However, if the "visitor" answers the question correctly, he wins the points. The corner spaces are squares that cause the players to either gain or lose the number of points indicated without answering any questions. The player with the highest number of points at the end of a designated time is declared the winner.

PREPARATION: The author suggests that the teacher cement, glue, or tape the playing board to a piece of heavy cardboard before play begins. The tetrahedron-shaped name markers and ownership markers also have to be cut out and put together.

COMMENTS: This game seems to be an excellent way of reviewing certain scientific principles and facts. A teacher may want to design additional question cards or adapt a special set of question cards for less advanced students.

The game has two important factors that help to insure active involvement of all participants at all times: 1) Another player must read the question to the player who has moved his marker which helps to insure that all persons will listen to the questions as they are being read and formulate their own answers to them). 2) By owning the squares a player is motivated to keep track of other students' answers because incorrect answers can mean points to the player owning the square.

TITLE: SWITCH PEGS

GRADE LEVELS: 4th–12th

PURPOSE: To develop logical thought processes by involving the student in identifying the particular pattern of moves which leads to the solution of a puzzle.

PLAYING TIME: varies

NUMBER OF PLAYERS: 1

PRICE: $1.00

DEVELOPER: not listed

ORDER FROM: Lawrence Hall of Science, Workshop Room 150, Centennial Drive, University of California, Berkeley, California 94720

DESCRIPTION: This game is actually a puzzle that consists of a block of wood, a piece of pegboard, five yellow golf tees, and five blue golf tees.

The five golf tees of each color are lined up horizontally on either side of the piece of pegboard. There is one vacant hole between the two sets of tees. The object of the game is to switch the sides of the two sets of tees by jumping one opposite colored marker at a time or by moving one space at a time. When a player reverses the sides of each set of tees by following the directions above, he has solved the puzzle.

PREPARATION: All materials for this puzzle are included in the kit. It takes a minimal amount of time and effort to get the puzzle in playing order. The rules are easy and straightforward.

COMMENTS: This puzzle is simple to put together and a challenge for any student to solve. Many of the slower students may become frustrated; however, for others this "brain teaser" may offer several minutes of fun and relaxation. During this time students might try to develop some logical method of solving the puzzle, but others will just play with the markers until they tire of the game or find a solution.

TITLE: TAC-TICKLE

GRADE LEVELS: 10th–12th

PURPOSE: To provide opportunities for the utilization of strategy in the solution of problems.

PLAYING TIME: 10 minutes to several hours

NUMBER OF PLAYERS: 2

PRICE: $1.50

DEVELOPER: Harry D. Ruderman

ORDER FROM: Wff 'N Proof, Learning Games Associates, 1111 Maple Avenue, Turtle Creek, Pennsylvania 15145

DESCRIPTION: Game pieces include a foam playing mat approximately 11 × 11 cm with 20 playing holes, a cardboard playing board approximately the same size as the foam mat with 22 playing spaces, four blue player pieces, four red player pieces, and one instruction sheet.

There are numerous variations for using this game including the "regular" game with three variations, Chinese Tac-Tickle and three variations, plus variations under these titles: 1) Commutative, 2) Symmetric, 3) Timing, and 4) combinations of 1–3.

The object of the regular game is to get three of the same colored pieces in a row—vertically, horizontally, or diagonally without any vacant spaces intervening. The first player to get three in a line wins.

The Chinese Tac-Tickle uses the card with 22 spaces and the object is the same—to get three player pieces together in a row.

Variations utilize the basic play but add other conditions.

PREPARATIONS: Game rules and procedures are simple and to the point so little preparation is required in order to play any of the games and variations.

COMMENTS: A challenging game for certain type students—those who enjoy the chess-type situation.

The time for playing this game will vary significantly with players and could range from 10 minutes to an hour or more.

TITLE: **THINK—SCHOOL SAFETY**

GRADE LEVELS: 3rd–6th

PURPOSE: To help students learn more about safety precautions in and around their school.

PLAYING TIME: 15 to 30 minutes

NUMBER OF PLAYERS: 2 to 4

PRICE: free

DEVELOPER: Dorothy A. Moore

ORDER FROM: Your local Civil Defense Preparedness Agency; request: GAMES THAT TEACH.

DESCRIPTION: Materials required include a gameboard, a set of 36 "Think" cards, 4 player markers, and a spinner. The gameboard consists of 31 spaces, some with point indicators (+1, +2, −1, or −2 points) and some with question marks (requires the "think" cards). A school building is pictured in the center.

Players begin at "Start" and move the number of spaces indicated by the spinner. Landing on a "+2", for example, gives the player two points. Landing on a "?" requires the player to draw a "Think" card and answer the question. A correct response yields 3 points while an incorrect response results in the loss of three points.

Play ends when all players reach the school. The winner is the player with the highest point total.

PREPARATION: Game materials include a brief description of the school pictured in the center of the game board; the teacher should read this to the students and discuss it as thoroughly as needed at the time.

COMMENTS: Students will enjoy using this game and, if handled properly by the teacher, it should result in increased knowledge of and understanding of safety considerations in and around the school.

The teacher may want to prepare a larger and more durable gameboard plus laminate or otherwise make more durable the "Think" cards.

TITLE: **TOWER OF HANOI**

GRADE LEVELS: 4th–12th

PURPOSE: To teach the students the most logical number patterns to move a series of different size blocks from one post to another.

PLAYING TIME: varies (a specific time-limit may be set)

NUMBER OF PLAYERS: 1

PRICE: $1.05

DEVELOPER: not listed

ORDER FROM: Lawrence Hall of Science, Workshop Room 150, Centennial Drive, University of California, Berkeley, California 94720

DESCRIPTION: The game consists of several pieces of wood. The largest block with 3 holes is the base of the game. The three holes have dowels which fit snugly and are used as the stacking poles for the blocks. There are eight blocks of varying sizes included in the game with each block having a hole in the center to enable it to be placed on the stacking poles.

The game starts with all the blocks stacked on one of the poles in a graduated fashion. The largest block is on the bottom of the "tower" while the smallest block is stacked on top. The object of the game is to complete the tower from one post to one of the two remaining posts by moving only one piece at a time and never putting a larger piece on top of a smaller piece. The person who accomplishes this objective wins the game.

PREPARATION: No preparation is required to use this game.

COMMENTS: This game is one of several designed to enable students to participate actively in logical thinking. A teacher may want to use this one in conjunction with several others to insure that students practice the thought processes. Many teachers use these as incentives for completing regular classwork.

Time limitations should be established for each player to prevent any one player from monopolizing the game.

TITLE: **TRI-NIM**

GRADE LEVELS: 9th–12th

PURPOSE: To provide opportunities for students to develop logical thought processes.

PLAYING TIME: 30 to 60 minutes

NUMBER OF PLAYERS: 2 to 3

PRICE: $5.00

DEVELOPER: Bruce Hicks and Hervey C. Hicks

ORDER FROM: Wff 'N Proof, 1111 Maple Avenue, Turtle Creek, Pennsylvania 15145

DESCRIPTION: Materials provided are a game board (approximately 27 × 21 cm) made of 4 interlocking pieces of stiff paperboard, a set of 45 plastic counters (about the size of a nickel)—36 red, 3 blue, 3 green, and 3 yellow, instructions for play, and a plastic box to hold the above.

The game board has printed on it an equilateral triangle with 36 smaller triangles and each triangle has a number (1, 2, 2', 3, 4, 5, or 6).

Play begins when P_1 (Player 1) places markers in the triangles with 0 at the center of the large triangle. Players then move, according to instruction, towards the acute angles or corners of the large triangle. The object of the game is to win the corners and scoring revolves around the order of winning those corners.

PREPARATION: The only preparation required will be to fully understand the rules and sequence of play and this will be necessary only the first time the game is utilized.

COMMENTS: As indicated on the game board, **TRI-NIM** is "The Game for Compleat Strategysts"—"Another Game for Thinkers"—and it is just that. There are provided the mathematical descriptions of the rules of **TRI-NIM** plus variations of play: "The Beginner's Game," "An Advanced Game," and "Triple Tri-Nim."

This game is obviously well designed and planned and will be a definite challenge to certain types of students.

The time required will vary with the skill of the players. 30 to 60 minutes should be adequate to get started with the less difficult games.

TITLE: WFF 'N PROOF

GRADE LEVELS: 2nd–12th

PURPOSE: To provide practice in abstract thinking and to teach some mathematical logic: learning by doing and a maximum of self-discovery.

PLAING TIME: 30 minutes and up.

NUMBER OF PLAYERS: 1 and up

PRICE: $12.00

DEVELOPER: Layman E. Allen

ORDER FROM: Wff 'N Proof, 1111 Maple Avenue, Turtle Creek, Pennsylvania 15145

DESCRIPTION: Equipment provided includes 18 capital-letter cubes (each imprinted with C, A, K, E, N, and R), 18 small letter cubes (each imprinted with p, q, r, s, i, and o), 3 WFF 'N PROOF mats (1 playing mat, 1 essential parts mat, and 1 permitted parts mat), 1 manual of instructions, 1 "hour-glass" timer, and one storage case (approximately 21.5 × 15 × 3 cm).

WFF 'N PROOF is a series of games, twenty-one total, with a wide variation in complexity. Thus, designers claim that the games can be played by learners of widely varying ages and abilities, beginning as early as age 6.

There are a total of 13 ideas introduced and used repeatedly in the play of **WFF 'N PROOF** games: the definition of Wff, the definition of a Proof, and the eleven rules of inference.

PREPARATION: Little preparation time is required to actually play the games but ample time will be necessary to understand fully the roles and procedures.

COMMENTS: **WFF 'N PROOF** represents the evolution of the first efforts (in 1956) of the author and his team in the development of mathematical games of logic.

This game (or series of games) is well thought out, designed, and equipped. Students, to most effectively utilize the game, must be motivated toward this type of activity and should be reasonably good students. Both teachers and students must spend some time with the

manual of instructions because the rules and procedures are not particularly simple.

Time can vary depending upon the game played and the skill and understanding of the players. Estimated time is 30 minutes to several hours.

APPENDICES

APPENDIX A: DEFINITIONS

There are a number of terms used to identify a game-like teaching strategy. These include: game, simulation, role play, instructional game, and simulation game. To clarify the differences in meaning of these terms, the following definitions are provided.

A game may be defined as an activity that is governed by a set of rules which provides a means of evaluating the success of a participant's play.

A simulation is defined as an operational activity which represents an actual situation that could occur in real life. In order for a simulation to be successful, it must be operational and include only the significant characteristics of the real world event.

A role-play is the acting out of hypothetical roles by participants who use their own imaginations and feelings. Role-play is the least formalized of any of the game-like activities. The players are given only a description of each person's role and a description of a specific situation in which they are to act out their roles.

An instructional game is an activity that is governed by a set of rules which provides a means of evaluating the success of a participant's play and is designed to teach a concept, fact, attitude, or skill.

A simulation game has all the characteristics of a game and of a simulation. Therefore, one could define it as an activity that is governed by a set of rules which represents an actual event that could occur in real life.

APPENDIX B: A HISTORICAL PERSPECTIVE

Educational games represent an instructional technique that has been increasingly used during the last ten to fifteen years. Gaming itself, however, dates back thousands of years. The Chinese had a war game entitled "Wei-Hai," which means encirclement, which originated about 3,000 B.C. India had a similar war game called "Chaturanga," which is thought to be the possible forerunner of chess. Chess was a popular war game of the Middle Ages. The military used simulation training games extensively in the two world wars. The American business sector was impressed by the military's use of simulation gaming in training; they now include the technique in their management training programs.

As funding for American curriculum projects expanded in the early 1960's, the curriculum developers began to look for new methods and strategies for teaching students. Gaming was studied and in many cases adopted for use. Two examples of curriculum projects which utilized simulations and games are *The American High School Geography Project* and Bruner's *Man: A Course of Study*. The early evaluations by teachers and students of the three simulations developed by *The American High School Geography Project* were so high, in fact, that the project staff increased the number of simulations in their subsequent units.

The development of games and simulations was followed, in many cases, by research studies to determine the effectiveness of game use. Since often the research studies were conducted by the same people who developed the games, Livingston and Stoll caution teachers about accepting the results at face value.[1] Their major concern is the objectivity of the researcher, for they feel that many times the researcher might see something he "wants" to see or misinterpret what is actually seen.

Gaming has passed through three phases in its use as a teaching technique. As first recognized by Boocock and Schild, Phase One has been termed "acceptance on faith."[2] It was during this phase, which lasted until 1962 or 1963, that the social educators first "discovered" gaming as a possible strategy and these educators were quick to accept

[1] Samuel A Livingston and Clarice Stoll, *Simulation Games: An Introduction for the Social Studies Teacher*, (New York, Free Press, 1973); p. 32.

[2] Sarane E. Boocock and E. O. Schild, *Simulation Games in Learning*, (Beverly Hills, Sage Publications, Inc., 1968), p. 15.

new games that were being developed without any "hard" evidence of their effectiveness. Many unsubstantiated claims for games were made during this phase. Gaming was a new teaching technique during this stage and most of the interested people's energies were used to develop, rather than test, the technique. Often the enthusiasm and involvement of the students participating in a simulation game made observers accept the fact that learning was taking place.

Phase Two was labeled as the "post-honeymoon period" and occurred during the years 1962–1965. Boocock and Schild recognize this period as one in which researchers attempted to carry out controlled experiments with games. The results of many of these experiments were not consistent, not significant, or even negative. They list the following conclusions regarding this phase of gaming: (a) that games are not a panacea for all educational ills; (b) that many games in their present form have serious flaws, and (c) that neither standard tests nor the relatively crude instruments designed specifically to evaluate a particular game or games are adequate or sufficient measures for the impact of games.[3]

Phase Three (1966 to present) is called the era of "realistic optimism." During this phase, a more realistic attitude has been taken concerning educational games. Boocock and Schild claim that since 1966 the following have occurred and are continuing:

1. games are being field tested in a wide variety of educational settings. (This has led to the alteration of various games to make them more valuable for a particular kind of student.)
2. a pool of data on the learning effects of specific games is being collected. (In many cases a game has been evaluated by several different researchers other than its designer.)
3. researchers are using their data to revise and clarify the claims concerning what games can do in the classroom.[4]

Many researchers feel that as progress is made along these three fronts, gaming will be shown to possess a high degree of effectiveness as a teaching strategy.

One important fact is certain: games are being designed and produced in increasing numbers. David Zuckerman and Robert Horn have identified over 600 simulations in twenty different subject areas in their directory entitled *The Guide to Simulation Games for Education and Training*.[5] Jean Belch has also identified over 900 "decision-making or

[3] Sarane E. Boocock and E. O. Schild, *Simulation Games in Learning*, (Beverly Hills, Sage Publications, Inc., 1968), pp. 16–17.
[4] Sarane E. Boocock and E. O. Schild, *Simulation Games in Learning*, (Beverly Hills, Sage Publications, Inc., 1968), pp. 17–18.
[5] David Zuckerman and Robert Horn, *The Guide to Simulations/Games for Education and Training* (Lexington, Mass., Information Resources, Inc. 1973).

problem-solving exercises" in her publication entitled *Contemporary Games*.[6] The fact that simulation games are being developed at such a rapid rate suggests the need for an increased amount of research on the technique of gaming. This research could lead to a much quicker revision and clarification of the claims for games as a teaching strategy.

[6] Jean Belch, *Contemporary Games* (Detroit, Gale Research Company, 1973).

APPENDIX C: LIST OF PUBLISHERS

Addison-Wesley Publishing Co.
Menlo Park, CA 94025

American Forest Institute
1619 Massachusetts Avenue, N.W.
Washington, D.C. 20036

Ampersand Press
2603 Grove Street
Oakland, CA 94612

Chemical Teaching Aids
Letham–Ladybank
Fife,
KY7 7RN
Scotland

Civil Defense Preparedness Agency
contact (Local State)

Damon
Educational Division
80 Wilson Way
Westwood, MA 02090

Dawson, Rosette
1015 Whitestone Lane
Houston, TX 77090

Discovery Corner
Lawrence Hall of Science
University of California
Berkeley, CA 94720

E-Z Science Games
9208 LeVelle Drive
Washington, D.C. 20015

Edison Electric Institute
90 Park Avenue
New York, N.Y. 10016

Educational Materials and Equipment Co.
P.O. Box 17
Pelham, N.Y. 10803

ERIC Information Analysis Center for Science, Mathematics, and Environmental Education
The Ohio State University
1200 Chambers Road 3rd Floor
Columbus, OH 43210

Estimetrics
Box 3138
Columbus, OH 43210

The Fun Time Company
1374 Glenrock Avenue
Maryland Heights, MO 63043

Gale, Clifford
Biology Department
Cazenovia High School
Cazenovia, N.Y. 13035

Games Central
Abt Associates, Inc.
55 Wheeler Street
Cambridge, MA 02138

Ginn and Company
191 Spring Street
Lexington, MA 02173

Groffman, Martin
Leonardo da Vinci Intermediate School
61 Q
98–50 50th Avenue
Corona, N.Y. 11368

Harwell Associates
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Convent Station, N.J. 07961

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One Beacon Street
Boston, MA 02107

Ideal School Supply Company
11000 S. Lavergne Ave.
Oak Lawn, IL 60453

Instructional Simulations Inc.
2147 University Avenue
St. Paul, MN 55114

Interact
Box 262
Lakeside, CA 92040

Intercom
218 East 18th Street
New York, N.Y. 10003

International Learning Corporation
245 South West 32nd St.
Fort Lauderdale, FL 33315

J-Squared Plus One
P.O. Box 747
Athens, OH 45701

Kendall/Hunt Publishing Co.
2460 Kerper Boulevard
Dubuque, IO 52001

Kent Educational Services
P.O. Box 903
Oviedo, FL 32765

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900 East State St.
Athens, OH 45701

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University of California
Workshop Room 150
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Minnemath Center
University of Minnesota
720 Washington Ave. S.E.
Minneapolis, MN 55414

N. Strand
521 North Marion St.
Oak Park, IL 60302

National Aeronautics and Space Adm.
Space Science Education Project
411 East Capital Street, S.E.
Washington, D.C. 20003

National Wildlife Federation
1412 16th Street, N.W.
Washington, D.C. 20036

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Science Education Center
School of Education
Norfolk, VA 23508

Optometric Development Enterprises
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San Jose, CA 95126

Public Service Company of Colorado
Publications Department
550 15th Street
Denver, CO 80201

Real-T-Facs
26 Overlook Drive
Drawer 449-B
Warwick, N.Y. 10990

Science Kit, Inc.
777 East Park Drive
Tonawanda, N.Y. 14150

P. A. Schiller and Associates
P.O. Box 307
Chicago, IL 60690

Southern Forest Institute
One Corporate Square N.E.
Suite 280
Atlanta, GA 30329

Sunkist Growers, Inc.
Consumer Services
P.O. Box 7888 Valley Annex
Van Nuys, CA 91409

The Teaching Aids Co.
59 Kelsey View Drive
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Teaching Concepts, Inc.
230 Park Avenue
New York, N.Y. 10017

Tecolote Press, Inc.
Box 217
Glenwood, N.M. 88039

Union Printing Company, Inc.
17 West Washington St.
Athens, OH 45701

Wff 'N Proof
1111 Maple Avenue
Turtle Creek, PA 15145

BIBLIOGRAPHY

Books

Belch, Jean. *Contemporary Games*, Vol. I–II, Gale Research Company, Detroit, Michigan, 1973 and 1974.

The author describes over 900 game-like exercises in 43 different areas. The games are also indexed according to grade levels. Belch emphasizes non-simulation games in the areas of math and English and about one-third of the book is devoted to business simulations. There are several areas in the book that include science-related games.

McLean, Harvard and Steven Hawley. *A Directory of Environmental Simulations and Games*, The Simulation and Gaming Association, Lebanon, Ohio, 1974.

The authors review over 50 simulations and games involving the environmental sciences. The following information is given for each game: title, game type, player level, number of players, playing time, source, cost, and description. Addresses for the various game sources are also given.

The Science Teacher. "Instructional Games," 42:30–31, (January) 1975.

A brief listing of seventeen games pertaining to science. The entry for each game includes: Title, publisher, price, science area, grade level, number of players, and a one or two sentence description.

Stadsklev, Ron. *Handbook of Simulation Gaming in Social Education (Part 2: Directory)*, Institute of Higher Education Research and Services, University, Alabama, 1975.

Stadsklev reviews over 700 simulations in such science-related areas as anthropology, geography, health, and psychology. Although the book includes many social simulations not related to science, the author gives up-to-date information on many science games. The format of the reviews includes source, grade level, playing time, number of participants, cost, brief description, and comments (in some cases).

Two important aspects of this book include: 1) the cross reference matrix for games included in the book and 2) the extensive listing of outside sources. The matrix includes subject areas, grade levels, cost, and mode of availability and acts as a fast information guide to the games included.

The listing of outside sources includes a list of action centers, research efforts, and a bibliography of books and periodicals.

Woerner, Janet. "Games" and "Games II," *Ecosources*, Vol. 1, No. 12 (1972) and Vol. 2, No. 12 (1973). Available free through Janet Woerner at The Sunset Hill School, 400 West 51st Street, Kansas City, Missouri 64112.

In the first volume of this news pamphlet, Ms. Woerner briefly describes 24 games and simulations appropriate for the environmental sciences. The description usually describes type of game, cost, source, and a short summary.

The second volume includes 16 additional games suitable for the science classroom.

Zuckerman, David W. and Robert E. Horn. *The Guide to Simulation Games for Education and Training* (Second Edition), Information Resources, Inc., Lexington, Massachusetts, 1973.

The authors describe over 600 simulations and games using a format similar to the one used in this book. Although one-third of the book is devoted to business-related simulations, there are sections that have reviews of games that could be used in a science classroom. The following science-related sections are included in this publication: Urban-Community Issues, Ecology, Social Studies, General Science, Health Care, Geography, and Special Interest. These areas include over 125 games.

There are also three very interesting articles about simulation gaming that would benefit the novice. "Getting Into Simulation Games," "How Students Can Make Their Own Simulations," and "A Basic Reference Shelf on Simulation and Gaming" are excellent articles.

Periodicals

SAGSET Journal, Society for Academic Gaming and Simulation in Education and Training, Centre for Extension Studies, University of Technology, Loughborough, Leics, LE11 3 TU, England.

This periodical is the official publication for the Society for Academic Gaming and Simulation in Education and Training. It is published four times a year and includes articles about gaming in education and other areas from American and British authors.

Simulation and Games, Sage Publications; Beverly Hills, California.

This is a quarterly periodical which places major emphasis on research on all aspects of games and game theory. This publication is for the person who is serious about game theory, research, and design.

Simulation/Gaming/News, Simulation Gaming News, Inc., Box 3039, University Station, Moscow, Idaho 83843.

This publication is published six times a year in tabloid form. It includes reviews of books and games, brief articles, actual simulations,

information on gaming groups and meetings, and a "checklist"—a current list of gaming articles found in *Research in Education* and *Current Index to Journals in Education*. This list has sections on "Science and Math," "Land Use, Urban and Environmental Planning," and "Research and Evaluation" which have articles pertaining to science teaching.

Books and Articles Containing Actual Games

Barr, Bonnie. "Disaster is the Name of the Game," *Science and Children*, 8:24–25, November 1970.

In this article an environmental board game for elementary students is described. *Disaster* is a game designed to increase students' awareness of the limited supply of air, food, and water available for use by the human population. (See write-up in this book about *Disaster* for additional information.)

Demchik, Michael J. "Classroom Checkers," *The Science Teacher*, 36:82, December 1969.

Demchik describes a game he developed to teach an item or concept in any of the science areas. This game is played by using a standard checker game. Students identify the item or concept after reading clues from the bottom of a captured checker. (See write-up on *Classroom Checkers* for additional information.)

Engs, Ruth, S. Eugene Barnes, and Molly Wantz. *Health Games Students Play, Creative Strategies for Health Education*, Kendall/Hunt Publishing Company, Dubuque, Iowa, 1975.

This book includes over seventy games on such areas as drugs, diseases, ecology, nutrition, human sexuality, and personal hygiene. The following information is given for each game: title, background, purposes, materials, description for presentation, discussion questions, and important considerations.

Many of the games in this book could be successfully implemented in the science classroom.

Gold, Leslie Jay. "The Pollution Game," *The Science Teacher*, 39:52–53, October 1972.

This short article describes an environmental game designed to introduce students to the complexities of environmental problems. Students take on roles of community citizens. The game centers around the production of paper airplanes with the greatest amount of profit and the least amount of pollution. (See write-up on *The Pollution Game* for more information.)

Goodman, Richard E. "The Game of Metabolism," *The American Biology Teacher*, 34:75–83, February 1972.

The author describes a board game which he developed to teach the intermediate steps of metabolism. All rules and game components are clearly stated or shown in diagrams in this article. (For more information see the write-up on *The Game of Metabolism.*)

Hazen, Jane. "Games in Environmental Education," *Science and Children*, 12:22–23, November–December 1974.

Hazen describes a game entitled *Eco-nopoly* which she developed to be used in the elementary science classroom. The article gives a description of the game and states the rules for playing it. Hazen also describes four additional environmental games that are suitable for the elementary science classroom.

Kuhn, David J. "A Simulation Game on Natural Selection," *The Science Teacher*, 36:68, January 1969.

Kuhn describes a simple game to show that the environment interacts with an organism's specific characteristics to bring about the process of natural selection. The game involves creating two woodland scenes and placing insects of different colors in each scene. Students then remove all the insects they see in a given time period. The data is analyzed and discussed. (See write-up on *Natural Selection.*)

Plat, Thomas J. "Role Playing—An Exciting Way to Explore the Atom," *The Science Teacher*, 37:81–82, February 1970.

Plat describes a role-playing exercise he uses to teach chemistry students about the way electrons fill the orbitals and shells of an atom. (For more information see *Role Playing—An Exciting Way to Explore the Atom.*)

Perry, Oliver and Reed Campbell. "Vector Navigation—A Game for Physics," *The Science Teacher*, 38:53–54, April 1971.

The authors describe a game for physics students that gives them the opportunity to plot vectors graphically and estimate the position and displacement given three vectors. (For more information see the write-up for *Vector Navigation.*)

Thiagarajan, Sivasailam. "Gamegame II," *Phi Delta Kappan*, 60:474–77, March 1974.

This article does not describe an actual science game. Instead it describes a game that affords teachers the opportunity to practice distinguishing among instructional materials, simulations, games, instructional simulations, instructional games, simulation games, and instructional simulation games.

Books and Articles of Additional Interest to the Science Teacher

Abt, Clark C. *Serious Games*, The Viking Press, New York, 1971.

Abt, Clark C. and Virginia H. Cogger. "Educational Games for the Sciences," *The Science Teacher*, 36:36–39, January 1969.

Allen, L. E., Robert Allen, and James C. Miller. "Programmed Games and the Learning of Problem-Solving Skills: The Wff 'N Proof Example," *The Journal of Educational Research*, 60:22–25, September 1966.

Boocock, Sarane S. and E. O. Schild (editors). *Simulation Games in Learning*, Sage Publications, Inc., Beverly Hills, California, 1968.

Carlson, E. *Learning Through Games*, Public Affairs Press, Washington, D.C., 1969.

Chartier, Myron R. "The Ten Commandments for Game Facilitators," *Simulation/Gaming/News*, 11:8–9, March 1974.

Coleman, James S. "Academic Games and Learning," National Association of Secondary School Principals Bulletin, 52:62–72, February 1968.

Davis, A. R. "Motivate Science with Games," *The Instructor*, 82:49–50, December 1972.

Doran, Rodney L. and William Watson. "Games for the Science Classroom," *The Science Teacher*, 40:31–33, 59–62, April 1973.

Farran, Dale C. "Games Work with Underachievers," *Scholastic Teacher*, 10–11, November 9, 1967.

Finch, Curtis R. and Patrick A. O'Reilly. "The Effects of Simulation on Problem Solving Development," *Simulation and Games*, 5:47–71.

Gillespie, J. A. "Analyzing and Evaluating Classroom Games," *Social Education*, 1:33–42, 1972.

Gilliom, M. Eugene. "Trends in Simulation," *The High School Journal*, 58:265–272, April 1974.

Glazier, Ray. *How to Design Educational Games* (5th edition), Abt Associates, Inc., Cambridge, Massachusetts, 1974.

Gordon, Alice Kaplan. *Games for Growth*, Science Research Associates, Chicago, Illinois, 1970.

Greenblat, Cathy S. and Richard D. Duke (editors), *Gaming-Simulation: Rationale, Design, and Applications*, Halsted Press, New York, 1975.

Heitzmann, William Ray. *Educational Games and Simulations*, National Education Association of the United States, Washington, D.C., 1974.

Heitzmann, William Ray. "The Validity of Social Science Simulations: A Review of Research Findings," *Educaton*, 94:33–37, December 1973.

Henderson, B. G. and W. G. Gaines. "Assessment of Selected Simula-

tions and Games for the Social Studies," *Social Education*, 5:508–513, 1971.

Heyman, Mark. *Simulation Games for the Classroom*, The Phi Delta Kappa Educational Foundation, Bloomington, Indiana, 1975.

Inbar, Michael and Clarice S. Stoll. *Simulation Gaming in Social Science*, The Free Press, New York, 1971.

Kasperson, Roger B. "Games as Educational Media," *Journal of Geography*, LXVII:409–22, October 1968.

Kohl, Herbert R. *Math, Writing, and Games in the Open Classroom*, A New York Review Book, New York, 1974.

Livingston, Samuel A. and Clarice Stoll. *Simulation Games*, The Free Press, New York, 1973.

Maxon, Robert C. "Simulation: A Method that Can Make a Difference," *The High School Journal*, 57:107–111, December 1973.

McKenney, James L. and William R. Dill. "Influences on Learning in Simulation Games," *The American Behavioral Scientist*, 10:28–32, October 1966.

McLean, Harvard W. "Simulation Games: Tools for Environmental Education," *Elementary School Journal*, April 1973.

Nesbitt, William A. *Simulation Games for the Social Studies Classroom*, The Foreign Policy Association, New York, 1971.

Ochoa, Anna. "Simulation and Gaming: Simile or Synonym," *Peabody Journal of Education*, September 1969.

Rasmussen, Fred. "Science Teaching and Academic Gaming," *American Biology Teacher*, 31:559–62, December 1969.

Rogers, Virginia and Marcella Kysilka. "Simulation-Games . . . What and Why," *The Instructor*, 79:94–95, March 1970.

Ryan, T. Antoinette. "Use of Simulation to Increase Transfer," *The School Review*, 76:246–252, June 1968.

Taylor, John L. and Rex Walford. *Simulation in the Classroom*, Penguin Books, Inc., Baltimore, 1972.

Thiagarajan, Sivasailam (editor). "Current Trends in Simulation/Gaming," *Viewpoints*, Bulletin of the School of Education, Indiana University, Publications Office, Room 109, School of Education, Indiana University, 49: no. 6, November 1973.

Twelker, Paul A. "Some Reflections on Instructional Simulation and Gaming," *Simulations and Games*, 2:145–153, June 1972.

Twelker, Paul. *Instructional Simulation Systems: An Annotated Bibliography*, Continuing Education Publications, Corvallis, Oregon.

Wing, Richard L. "Simulation as a Method of Instruction in Science Education," *The Science Teacher*, 35:41–42, May 1968.