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HUNTINGTON II Simulation Program – POLUT

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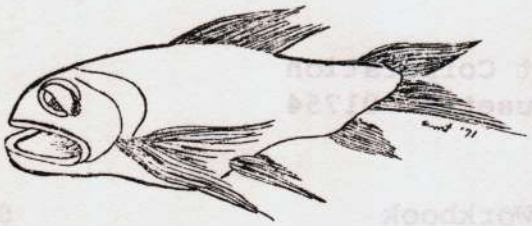
POLUT

TEACHER SUPPORT MATERIAL



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HUNTINGTON TWO COMPUTER PROJECT

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I. IDENTIFICATION

Subject Area:

Biology, Social Studies

Special Topic:

Water Pollution

Abstract:

The interaction between water and waste is simulated on the computer, providing a context within which the user can control specific variables which affect the quality of a water resource.

Grade Level:

10th - 12th

Coordinated Computer Program:

POLUT

Computer Language:

BASIC

Special Language Features Used:

TAB

Text References:

(See List of Resources)

II. DESCRIPTION OF THE POLUT PROGRAM

The computer program in this unit will simulate the effects of certain variables on the quality of a water resource. Complete lists and explanations of the assumptions, definitions, and equations which underlie the model used in the computer program are given in the POLUT Resource Handbook. In the POLUT program, the user can control the following parameters:

1) Type of body of water (large pond, large lake, slow-moving river, or fast-moving river)

2) Water temperature (in degrees Fahrenheit)

3) Type of waste released into water (industrial or sewage)

4) Rate of dumping of waste (in parts per million per day)

5) Type of waste treatment (none, primary, or secondary)

With respect to the temperature of the water, a range of 32° - 70° Fahrenheit is reasonable. Naturally occurring waters do not usually heat up to above 70° Fahrenheit, and below 32° Fahrenheit, of course, the water will freeze. It should be noted, however, that water may be polluted in such a way that it could be cooled below 32°. (This, in effect, is what anti-freeze in your car does.)

While varying parameter values with program POLUT, the rate of dumping waste should be kept between 0 and 14 parts per million per day. New York City pollutes its water at a rate of 12 parts per million per day, so this range is reasonable.

The ratio of one part per million (ppm) can be illustrated by the following examples:

1 in. = one ppm of 16 miles
1 lb. = one ppm of 500 tons
1 ¢ = one ppm of $10,000

After the variables have been entered, the computer will determine the oxygen content and the waste content of the water for each simulated day until the system reaches equilibrium, i.e., until the oxygen content and the waste content are constant. You can choose to have the computer print out this data in the form of a table, a graph, or both.

III. RATIONALE FOR THE POLUT UNIT

Many relevant social problems today center on the management and quality control of natural resources. In the process of becoming well informed, responsible citizens, students at the secondary school level should acquire some understanding of and insight into these ecological problems. The POLUT unit capitalizes on a manageable portion of the mammoth water pollution problem. It provides a context within which students can gain substantial understanding of the basic scientific and economic factors involved in the water pollution problem. Using the medium of the computer, students can investigate the effects of variables, compare various pollution control strategies, examine hypothetical situations, make and test hypotheses, and predict the implications of certain scientific and economic decisions. Such a degree of student involvement is in stark contrast to that which is traditionally available and can significantly enhance the student's interest and learning. In addition, the student is able to experience science as an active process of inquiry.

IV. GOALS FOR THE POLUT UNIT

When a student has completed a unit of study centered on the POLUT program, he should be able to:

1) Briefly describe the process of waste breakdown in water, and the importance of oxygen to this process.

2) Describe the effects of each of the following variables on the water's ability to handle wastes:

   a) the type of body of water
   b) the water temperature
   c) industrial waste
   d) sewage
   e) rate of dumping of waste
   f) no treatment of waste
   g) primary treatment of waste
   h) secondary treatment of waste

3) Describe the effects that reduced oxygen in water can have on the life of fish.

4) Briefly describe: a) the process of primary waste treatment; b) the process of secondary waste treatment.

5) List at least five questions which would be significant in investigating a local water-pollution problem.

V. BASIC INSTRUCTIONAL USE OF POLUT

The major instructional use of POLUT is for increasing the student's understanding of and insight into the ecological problem of water pollution.

Activities Preparatory to the Use of POLUT

1) Before the POLUT program is used, the teacher should ascertain that the students clearly understand the following notions:[1]

   a) how water acts on waste
   b) the importance of the oxygen level in water with respect to:
      (i) waste breakdown
      (ii) fish which inhabit the water
   c) the types of human waste:
      (i) sewage
      (ii) industrial
      (iii) agricultural
   d) the difference between degradable and non-degradable wastes
   e) the processes involved in primary and secondary waste treatment
   f) the effects of temperature on the physical properties of water and oxygen.

2) The teacher should explain the terms and units to be used in the program (see Section II, DESCRIPTION OF THE POLUT PROGRAM).

3) The teacher should be sure the students realize that the program POLUT is a simulation, and that it operates under certain assumptions. These assumptions should be discussed in class. (See POLUT Resource Handbook.)

4) The teacher should explain the form of the program POLUT and the procedures to be followed while using it.

Use of the Program

The program can be used by individuals, teams of students, or entire classes (with appropriate viewing equipment). Investigations with the program may concentrate on:

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[1] The Resource Handbook included in these materials should provide sufficient basic information and more extensive treatment can be found in the books listed in the list of resources.

1) The relative ability of each type of receiving body of water to handle waste.

2) The effects of thermal pollution (by varying temperature).

3) The effects of seasonal variations in the water (by varying temperature).

4) The relative effectiveness of no treatment of waste, primary treatment, and secondary treatment.

5) The effects of a variation in dumping rate.

6) The relative effects of industrial waste and sewage.

The program can be used to compare pollution-control strategies, examine hypothetical situations, make and test hypotheses, and predict the implications of certain scientific and economic decisions. If the teacher wishes, the experience with program POLUT can be treated as a laboratory experiment: for example, data is gathered, analyses are made, reports are turned in, and discussion follows.

Follow-up Discussion Questions

The following discussion questions may be used in addition to those generated by the students and the teacher.

1) What is the effect of each of the following variables on the oxygen content of the water?

   a) type of water body
   b) temperature of water
   c) type of waste dumped
   d) dumping rate of waste
   e) type of treatment of waste

2) Discuss any "trade-offs" which you found to occur among these variables. For example, how much can the dumping rate be increased if secondary treatment is used? How is the dumping rate curtailed if the water temperature is high?

3) How would one go about setting standards of water quality? What variables must be considered? Whose interests are involved? What value judgments must be made?

4) Suppose that an industrial firm is considering establishment of a plant on the shore of a river and that the firm produces a non-degradable waste material which when untreated is poisonous to fish. Suppose also that downstream from the proposed site of the firm, a commercial fishing company is operating and that it offers to pay the industrial firm either not to locate on the river or to treat their wastes so that they will not be toxic to the fish. Discuss the considerations that must be made by both firms. For example:

   a) How much should the fishery be willing to pay the chemical industry? Should it even <u>have</u> to pay?
   b) How much should the industry be willing to accept?
   c) Discuss the "rights" involved on the part of each firm.
   d) Investigate the legality of the whole issue.
   e) Would the purpose of the firm make any difference to your opinions? (For example, if the industrial firm produced chemicals to be used in the manufacture of medicines versus a firm which produced chemicals to be used in the manufacture of dyes for paper products?)

   (Note: These questions barely scratch the surface of the problem. It would be interesting to have the class formally debate a case such as this one. In this regard, Part II of the Kneese and Bower book (see List of Resources) gives an excellent presentation and discussion of the economic questions involved in the water pollution problem. The book is probably most appropriate for brighter high school students, although average students could profit from using it under the guidance of a teacher.)

5) One Dow Chemical Company official has said, "We are convinced that pollution control is part of the cost of doing business and we have always treated it that way. We firmly believe that industry can be clean and profitable at the same time, and we have amply proven this to our satisfaction".[2] Do you think that industry should be <u>required</u> to control its pollution? Should taxpayers be required to pay any of the cost of pollution control for private industry? Would taxpayers be indirectly taxed if the government were to give tax incentives to big business to control their pollution?

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[2] C. Gerstacker, "Management Role in Pollution Control", <u>Industrial Waste Engineering</u>, Vol. 3, No. 4 (1966), p. 39.

VI. TEACHER INTRODUCTION TO STUDENT MATERIAL

Since the computer simulation is really an "extended laboratory" experience, the student ought to have a record of it and a reference to it in much the same way that he has records of "traditional" laboratory experiences.

The exercises in the Computer Laboratory Guide represent only a sampling of the many types of investigations which are possible with POLUT. You will probably not want to assign your students all the exercises listed, and you may prefer to design problems of your own.