Sink or Swim game analysis

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INTRODUCTION

Education is one of the main functions at the SUNY-Oneonta Biological Field Station. *Sink or Swim* is an educational game that was developed by Field Station personnel and is designed to enhance the learning process using a relaxed atmosphere and student interactions. This game is a representation of the profundal food web that exists in Otsego Lake, demonstrating typical food web relationships and species interdependency. The effects of changes in the environment due to organic and inorganic pollution, harmful land use practices in the watershed, and attempts by society to mediate these problems are all issues in consideration during play.

There were five main objectives that the game was designed to teach students: (1) the dependency of organisms on each other and on their environment (2) the ecological levels of organization of the living world (3) the components that form and maintain an ecosystem (4) how interactions of living organisms and their environment result in succession, and (5) human influence on the balance of nature (*Sink or Swim* Teacher’s Guide, 1996).

*Sink or Swim* is not just a board game, but a component of a module of learning tools. The game was accompanied by an educational video called “Eye on Otsego” and a Teacher’s Guide. The purpose of these materials is to introduce essential new concepts and descriptive information about the creatures and plants in the food web not found in the average textbook, giving students sufficient background and preparation before the game is played. The game itself contains a game board for each player or team, species cards, action cards (pollution and mitigation activities), two dice, and enough ECU’s (Environmental Currency Units [$]) to give each player 200 and plus at least 500 for the bank (*Sink or Swim* Teacher’s Guide, 1996).

This study was undertaken to assess the effectiveness of the module as a learning tool. The creators of this game hope to increase the availability through transferring the game to computer software and by providing Internet access.

METHODS

During the 1996/97 school year, a number of modules were distributed to three schools in the surrounding area: Milford Central School, Owen D. Young Central School, and Schenevus Central School. The game was played by 152 students ranging from sixth to twelfth grade. "Sink or Swim Student Surveys" were distributed to the students before and after the module was used (Figure 1). These "surveys" were pre- and post-tests composed of thirty questions pertaining to lake ecology. Additionally, student comments on the game were solicited. The surveys were collected, graded, and the results analyzed.

As a follow up test, Sink or Swim was played by 1997 high school and college interns at the Biological Field Station following a viewing of the video "Eye on Otsego". Surveys preceded and followed the game. These surveys were also graded and analyzed. Comments about the game and how it could be improved were acknowledged. The purpose of incorporating the Biological Field Station personnel in the study was to provide a sample group that was more knowledgeable about the issues addressed in the game.

Figure 1. Sink or Swim student survey, administered as pre-test and post-test.

These questions are multiple choice; choose the best answer.

1. Turbid water, large plant populations, and high nutrient concentrations are characteristic of...
   a. oligotrophic lakes.
   b. mesotrophic lakes.
   c. eutrophic lakes.
   d. dystrophic lakes.

2. The compensation level in a lake...
   a. is a function of animal growth.
   b. is at the top of the littoral zone.
   c. equals the deepest point at which plants can grow.
   d. is a function of temperature and plant growth.

3. The profundal zone is to light as the hypolimnion is to...
   a. dark.
   b. temperature.
   c. the littoral zone.
   d. the epilimnion.

4. A limiting factor is
   a. any necessary substance in short supply for a population.
   b. one that precludes the introduction of exotics.
   c. independent of physical conditions.
   d. present in a multi-dimensional hypervolume.
5. Biodiversity is a measurement of the...
   a. sizes and numbers of organisms.
   b. species richness.
   c. comparative numbers of producers, consumers, and decomposers.
   d. numbers of species and their population sizes.

6. Remediation for non-point source pollution requires alteration of human activity that may be implemented by...
   a. land use regulations.
   b. introduction of zebra mussels.
   c. stimulating the growth of algae.
   d. potable water treatment.

7. The Phylum Arthropoda includes the Family...
   a. Mollusca (snails and clams).
   b. insecta (6 legged animals).
   c. Crustacea (cladocera and copepods).
   d. Chironomidae (midges).

8. Most aquatic invertebrate animals...
   a. are decomposers.
   b. are secondary consumers.
   c. are primary consumers.
   d. are primary producers.

9. Trout and salmon are found...
   a. above the thermocline.
   b. in deep, cold water.
   c. in productive lakes.
   d. in the limnetic zones.

10. A lake is...
   a. an ecosystem.
   b. a place where nutrients are dissipated.
   c. a place where energy is recycled.
   d. both a and c.

11. The sizes and numbers of algae in a lake are not dependent on...
   a. numbers of animals at the third trophic level.
   b. atmospheric (gaseous) nitrogen.
   c. the numbers of people living around the lake.
   d. the weather.
12. Overuse of fertilizer causes...
   a. destruction of algae and rooted aquatic plants.
   b. increase in water transparency.
   c. a shift in potential productivity towards oligotrophy.
   d. a loss of oxygen in deep waters.

13. Which of the following are pollutants from septic tank systems? Phosphorus and
   a. nitrates.
   b. phosphorus.
   c. potassium.
   d. both a and b.

14. Clear cutting of trees along lakes does not result in...
   a. eutrophication problems.
   b. non-point source pollution.
   c. increased energy cycling.
   d. thermal pollution.

15. Grazing cattle in the vicinity of the lake
   a. helps counteract the effects of eutrophication problems.
   b. creates toxic pollution.
   c. adds to nutrient loading.
   d. is a cause of point source pollution.

16. What is contained in motor oil that is toxic to organisms?
   a. PCBS.
   b. dioxin.
   c. hydrocarbons.
   d. all the above.

17. Decomposition of animal matter...
   a. disrupts nutrient cycling.
   b. provides oxygen for deep water organisms.
   c. occurs at the first or second trophic levels.
   d. provides nutrients for photosynthesis.

18. Natural ecological succession in lakes...
   a. cannot be determined without sophisticated equipment.
   b. is speeded up by pollution.
   c. cannot be reversed.
   d. occurs independently of living organisms.

19. Cold-water fish can thrive only in...
   a. lakes representing late successional stages.
   b. eutrophic lakes.
   c. lakes with well oxygenated deep waters.
   d. all of the above.
21. Cladocera are...
   a. producers.
   b. filter feeders.
   c. mollusks.
   d. all of the above.

22. In New York lakes, the limiting factor to plant growth is commonly
   a. phosphorus.
   b. iron.
   c. silt.
   d. both a and c.

24. Cladocera and copepods are...
   a. symbiotic.
   b. crustaceans.
   c. insects.
   d. mollusks.

25. Midges are...
   a. minnows.
   b. plants.
   c. insects.
   d. pea clams.

26. Oligotrophic lakes are characterized by...
   a. silty shores.
   b. clear waters.
   c. many plants.
   d. high nutrient concentrations.

The following questions are True/False. Please circle T or F.

27. T/F Non-point source pollution usually results in organic proliferation.

28. T/F During decay, blue-green algae often give off toxic products.

29. T/F Bacteria and fungi are regarded as "producers" in a lake's food web.

30. T/F Organic pollution is so-called due to its destruction of living organisms.

31. T/F The level of organic material in Lake Otsego has increased marginally since the 1930's.

32. T/F Water being drawn from the lake and returned colder is an example of thermal pollution.
RESULTS

Data collected from the Sink or Swim survey scores are illustrated in Tables 1 and 2. Figures 2 and 3 display the average percent improvement between Pre- and Post-tests in the four different educational institutions and by grade level. The results showed that students learned a minimal amount after playing the game with an average of 4% increase in score. However, the percent of increase in score varied from school to school. Milford Central and Schenevus Central Schools had very low increases in scores while the score increases from Owen D. Young Central School and the Biological Field Station were significantly higher.

Table 1. Average percent improvement by grade level.

<table>
<thead>
<tr>
<th>GRADE</th>
<th>COUNT</th>
<th>% IMPROVEMENT</th>
<th>STANDARD DEVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>31</td>
<td>1.72</td>
<td>10.73</td>
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<tr>
<td>7</td>
<td>27</td>
<td>6.97</td>
<td>11.16</td>
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<tr>
<td>9</td>
<td>27</td>
<td>4.07</td>
<td>10.64</td>
</tr>
<tr>
<td>10</td>
<td>65</td>
<td>4.66</td>
<td>11.37</td>
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<tr>
<td>12</td>
<td>2</td>
<td>-6.66</td>
<td>13.33</td>
</tr>
<tr>
<td>Total average</td>
<td>152</td>
<td>4.18</td>
<td>11.45</td>
</tr>
</tbody>
</table>
Table 2. Average percent improvement by educational institution.

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>COUNT</th>
<th>%IMPROVEMENT</th>
<th>STANDARD DEVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milford C. S.</td>
<td>23</td>
<td>2.60</td>
<td>8.82</td>
</tr>
<tr>
<td>Owen D. Young</td>
<td>17</td>
<td>11.17</td>
<td>10.15</td>
</tr>
<tr>
<td>Schenevus C.S.</td>
<td>11</td>
<td>3.45</td>
<td>11.56</td>
</tr>
<tr>
<td>Biological Field Station</td>
<td>11</td>
<td>11.51</td>
<td>8.91</td>
</tr>
<tr>
<td>Total average</td>
<td>7.18</td>
<td>9.86</td>
<td>9.87</td>
</tr>
</tbody>
</table>

DISCUSSION

An inquiry was made as to how the game and materials were presented to students, and it was found that the teachers from Milford Central and Schenevus Central had neglected to prepare students with the educational materials provided. Without giving the students any educational background, they gave the students the Pre-test, had them play the game for a 40 minute class period, and then administered the Post-test. However, at Owen D. Young Central, all educational materials were utilized, and the increase of score was 11.2%. This increase is comparable to the increase in scores of the Biological Field Station personnel which was 11.5%.

Scores of tests taken by the Biological Field Station interns were markedly higher than those of the high school students, but the increase of score was very similar to the school that presented *Sink or Swim* in the intended manner. It was concluded that *Sink or Swim* is effective in teaching students about the ecological state of inland lakes as long as the game is accompanied by sufficient preparation.
Figure 2: Average percent improvement between *Sink or Swim* Pre- and Post-test scores (N=150) per grade level, 1996-1997.

**NOTE:** Two students from the 12th grade were involved in the study, but due to small sample size, results are inconclusive.

Figure 3: Average percent improvement between *Sink or Swim* Pre- and Post-test scores (N=163) in four different educational institutions, 1996-1997.
STUDENT COMMENTS ABOUT SINK OR SWIM

Many students remarked that though the game was confusing at first, essentially they thought that the game was fun and interesting. Some appreciated the educational value of the game very much. Some mentioned that they thought the game would be fun to play on a computer.

Many students suggested that the instructions should be stated more clearly and the playing cards should be easier to read with simpler terminology. Others thought the game would be more interesting with a larger diversity of organisms and a larger board. Some felt that the game ended too soon.

Biological Field Station interns similarly commented that the layout of the game should be more clearly defined. Additionally, they commented that the survey had little to do with the actual game, which would account for the low scores.

From these student comments, it can be concluded that the game is successful in maintaining a person’s interest as well as teaching about lake ecology. However, the test could be redesigned to better reflect the educational content presented by the game. Again, this game is a component of a learning module; for it to serve its purpose as a successful educational tool, it is essential that it be preceded by viewing the video and the students having some familiarization with the Sink or Swim Teacher’s Guide. This study will help to determine whether this game should be refined and developed into educational computer software.

REFERENCES

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