Hydroville Curriculum Project

EVALUATION PHILOSOPHY AND OVERVIEW

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A dramatic social trend has been the rise in public awareness and sensitivity to environmental issues, as well as the importance of science as a resource for identifying and solving these problems. Statutes and laws, such as the 1970 National Environmental Protection Act (NEPA) and the 1974 Safe Water Drinking Act, have set in place procedures and processes to help insure that both scientific and public opinion are used to inform decisions about actions by government and industry that could or do lead to environmental impacts. The result of these trends has been to place control and responsibility in the hands of the general public to act and interact with each other and with scientific experts to bring about environmentally responsible decisions concerning every aspect of our environment including the air we breath, the water we drink, the homes we live in and the food we eat.

Environmental science is the cornerstone of knowledge upon which environmental decision making is based, and a scientifically-literate public is necessary to insure that environmental decisions are informed by the values and desires of those impacted. The essence of this process is democratic participation by members of the public, who must be capable of understanding environmental science principles and applying them in situations that require expressing views and working with others.

To support these needs, emphasis has been placed on science and mathematics as key elements of our educational system. In general, this has led to a burgeoning of curriculum materials in the area of science education and to the development of knowledge-based standards for assessing student achievement in various areas of science. However, standards for assessing science achievement tend to focus largely on the acquisition of knowledge and “facts” about science. Less attention has been paid to the development of curricula that both meets the need to increase students’ awareness and understanding of science principles and at the same time improves their ability to employ scientific knowledge as part of the process by which science is used to make decisions, both in their personal life as well as in society in general.

In addition, the view of science as a discrete area of education has tended to set science instruction apart from other instructional areas, such as language arts and social studies, preventing students understanding that solving environmental problems requires an interdisciplinary approach. The Hydroville Curricula have been designed to incorporate principles and process skills from multiple disciplines to help students participate as scientists and citizens in developing solutions to real world environmental health problems.

Overview

The goal of the Hydroville Curriculum Project was to develop curricula that enabled students to demonstrate improved academic performance, decision-making skills, attitudes toward science and school, and increased knowledge of environmental health issues. The Hydroville evaluation design was based on the three broad themes:

- Environmental science as a problem solving approach,
- Students’ self-efficacy and cooperative work skills as a basis for applying environmental science to real-world problem solving, and
- Inquiry as central to scientific processes.

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Student outcomes were assessed using exercises set in a problem solving context that paralleled the content and teaching model of the Hydroville curricula. The HCP instructional approach uses an *integrated teaching model* in which students engage environmental health science concepts through multiple disciplinary perspectives. The HCP curricula consist of activity modules that relate to a scenario in which students work individually and in teams to analyze, identify and communicate a solution to an environmental health problem. Students learn to:

- Employ inquiry skills as an investigatory process
- Understand and use environmental health science concepts,
- Analyze problems from an environmental health science perspective,
- Work with others to gather information, share knowledge and propose solutions,
- Understand and use decision making principles and methods, and
- Integrate their new learning into a scenario-based problem in which they are called upon to present their findings in written and oral form.

The skills developed while involved in the Hydroville curricula go well beyond the learning of science as a body of knowledge and facts. Students develop perceptions and attitudes about the relevance of science to social problems and daily life. They also develop a greater sense of self-determinacy and self-efficacy as individuals, and a greater capability to work in groups to bring about effective solutions to problems that have parallels to those in the real world. The Hydroville experience is geared toward environmental health science as an inherent a part of pluralistic, environmental decision making, for which a science-literate public is needed as a basis for integrating environmental science and social policy.

The general philosophy that has guided the development of the HCP was overlaid onto the evaluation design and used as the basis for developing a set of measurement concepts to detect change in important student outcomes, including:

- Adoption of a problem solving style based on environmental health science principles,
- Recognition of the importance and use of environmental health science information,
- Personal involvement and self-direction in environmental health and safety, and
- Self-efficacy and cooperativeness in working with others to address environmental problems.

These factors are strongly related to the process aspect of science as a contributor to environmental health and safety through the perception and assessment of environmental risk and the decision making behaviors that manage those risks. A key objective of the student outcomes evaluation is to assess students' attainment of important steps toward achieving a comfort level with environmental health science and with social participation in environmental problem solving, much as occurs in local communities and national debates about environmental issues. The Hydroville curriculum along with the evaluation framework is geared toward assessing students' progress in these areas.

The student outcomes evaluation was implemented in a pre/post test design. Each student was given a "Problem Solving Pretest" at the beginning of the nine-week Hydroville exercise, and a "Problem Solving Posttest" at the end. Students' served as their own control for measuring student change. The evaluation was administered in a paper-and-pencil format; students were presented with a problem solving situation in which they responded to a number of question-type items using a multiple-choice, structured response format. The items were organized into a set of scales that represent the key measurement concepts:

- Quality of explanations for an observed community public health effect;
- Information seeking attitudes and behaviors as part of identifying and analyzing a community public health effect;
- Self-evaluation of capability to work with others as part of a group problem solving approach;
- Attitudes toward self-protective behavior with regard to environmental risks;
- Perception of general health and safety risks, chemical risk and environmental risks;
- Value of science as part of social and personal health and safety decision making; and,
- Understanding of basic toxicological principles, including exposure and dose-response relationships.

In addition to the pre and posttest evaluation of student learning outcomes, qualitative data on students' perceived learning outcomes were collected. Selected students from two teachers who implemented the Hydroville curricula in year 2006-2007 were interviewed upon completion of student learning of the curriculum. During the interview, students were asked to characterize the curriculum and then state what they feel they have learned in order to measure students' perceived learning outcomes.

Student Outcomes

Pre and posttest data have shown that students engaged in the Hydroville curriculum:

- Gain sensitivity to the importance of environmental science concepts as a basis for evaluating the quality of explanations for observed public health effects;
- Understand scientific inquiry as a process rather than a series of steps;
- Adopt thought styles for analyzing environmental problems that are more like those of environmental science professionals;
- Increase their recognition of the importance and value of information seeking as part of problem identification and analysis;
- Increase their personal level of self-efficacy with regard to taking an active role in environmental problem solving;
- Develop a great level of comfort and facility at presenting solutions to environmental problems in written and oral form;
- Develop important skills for working with others to analyze and propose solutions to environmental problems;

- Develop a greater appreciation for the role and value of science as a resource for solving problems in daily life;
- Increase their perceptions of environmental health and safety risks; and,
- Develop greater awareness of the importance of personal, risk-reducing behaviors with regard to environmental hazards in the home.

Student interview data have shown the various ways in which students characterize the Hydroville curriculum. Their characterization, however, was mostly in two dimensions: pedagogical dimension and content dimension. The former included worksheet driven, problem-solving driven, hands-on driven, investigation driven, group-work driven and/or self-teaching. Other students characterized the curriculum in terms of the content: studies about water contaminants or air quality, environmental effect on health, practical information, and/or flow of underground water or measure of air quality.

The characterization of the curriculum was, however, not closely related to students' perceived learning outcomes. When asked about what they learned throughout the curriculum 11 out of 19 students mentioned increased awareness of "the effect of air quality" "water contaminants", or "water problem." For example, one of Mrs. K's students mentioned, "It pretty much opens up everybody's mind. . .beyond pollution. . . so many different things are wrong. . . . I think it helps us. . .what to look for and how to keep our places clean" (TK). Others mentioned content learning by providing detailed contents covered in class while only one mentioned inquiry skills without prompt. Although those who characterized the curriculum in terms of its content tended to mention specific contents as their learning outcomes, there was no clear pattern between students' perceptions of the curriculum and their learning outcomes.

The qualitative data confirms the quantitative data that demonstrated students' increased scientific disposition toward environmental health issues but falls short of confirming students' learning inquiry skills. Although many students characterized the curriculum as problem-solving oriented or investigation oriented they rarely mentioned their inquiry skills as learning outcomes.