EVALUATION OF THE EXTENT TO WHICH A STUDENT RIVER MONITORING PROGRAM IN SHEBOYGAN COUNTY, WI, INFLUENCES STUDENT'S VALUES, BEHAVIORS, KNOWLEDGE, AND ACTION SKILLS REGARDING ENVIRONMENTAL EDUCATION AND AQUATIC ECOLOGY

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A Research Proposal Submitted in Partial Fulfillment of Masters of Science in Environmental Education at the University of Wisconsin-Stevens Point

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Abstract

A student water testing project involving several schools in Sheboygan County was developed in the Fall of 1997. The major goal of the project was to prepare students to become active participants in the resolution of local environmental issues. Allowing students to investigate an environmental issue, such as river water quality at the community level, would allow students to gain the necessary experiences, knowledge, and action skills to attain this goal.

During the 1997-98 school year, students participating in the project were evaluated on the project's impacts on student's environmental values, behaviors, knowledge, and action skills using a pre/post survey. A control group of students was also surveyed using the same survey instrument. All students surveyed were from Sheboygan South High School, Sheboygan Wisconsin. Both treatment and control groups were surveyed in September 1997 and again in May 1998. Conclusions were drawn based upon comparison of the pre and post data.

The survey results indicated that the treatment group improved mean percentage scores in all four categories from the pre to post surveys. The control group only improved scores in the environmental knowledge category.

These results indicate that a student environmental monitoring program does have an impact on student's environmental values, behavior, and action skills. Environmental knowledge scores improved for both groups of students indicating that the project had a lesser effect in this category. To better attain the goal of active citizen preparation among students, projects that require active student participation, such as a student water testing project, are more effective than traditional classroom methodologies.
Introduction

Statement of the Problem

The purpose of this project is to develop a water testing project and evaluate its impacts on the values, behaviors, and action skills of students from several school districts in Sheboygan County, Wisconsin.

Subproblems

1. The first subproblem is to identify, recruit and maintain teachers and community members to participate in the water testing project.

2. The second subproblem is to set clear objectives for a program that addresses three of the Wisconsin Department of Public Instruction’s (DPI) environmental education (EE) objectives. These are: student knowledge, values, and citizen action skills.

3. The third subproblem is to locate a suitable instrument for use in the survey of control and treatment groups.

4. The fourth subproblem is to identify a control group of students against which to compare the treatment group with regards to environmental knowledge, values, behaviors and citizen action skills.

5. The fifth subproblem is to administer the pre/post survey to the treatment and control groups and to interpret and compare the data.

Significance of the Problem

One of the primary goals of EE is changing student behavior "favorably" in regard to the
environment. By "favorably" it is meant that students will make decisions regarding the 
environment which balance the ecological needs of the environment and that of the community in 
which they live. This behavior should be exhibited through positive environmental actions by 
participants in EE programs. However, EE has produced ecologically concerned citizens who are 
armed with ecological myths, but lack the knowledge and conviction of their own role in 
environmental problems (Gigliotti, 1990), and lack the skills needed to take appropriate action 
in regards to the environment.

When considering the Wisconsin DPI objectives, student values, action skill 
development and action experiences are recommended areas of emphasis at the senior high level 
(Engleson and Yockers, 1994). Analysis of teaching objectives with respect to EE at this level 
suggests that most EE occurs at the attitudes and knowledge level, even in the secondary grade 
levels (Lane, 1993). Teaching strictly knowledge is problematic because it does not change 
learner environmental behaviors (Thompson and Gasteiger, 1985). Even worse, ecological 
knowledge is not retained well when only knowledge objectives are taught (Arcury and Johnson, 
1986). This problem can be explained by the traditional thinking in the field of EE, which has 
been that behavior can be changed by making students more knowledgeable about the 
environment and its associated issues (Hungerford and Volk, 1990).

Current literature indicates that issues must be the focus of instruction, and that 
students must be given the opportunity to develop the sense of "ownership" and 
"empowerment" that a successful action experience provides (Hungerford and Volk, 1990). 
These are essential for learner behavior change to occur. In a broader sense, the techniques that 
have resulted in consistent behavior change are antecedent conditions, commitment, modeling, 
and goal setting strategies (Dwyer and Lemming, 1993). Long term environmental monitoring 
projects, such as river water testing, provides students, teachers and community members the 
type of long term, issue oriented project that research has shown is more likely to change 
participant behavior. Further it requires participants to set new goals while drawing from 
antecedent conditions, which Dwyer and Lemming (1993) indicate are critical to changing
Limitations

1. The project will be limited only to students from Sheboygan County; thus results will be
generalized only to those schools participating.

2. The project will not require participation of teachers lacking an interest in the
program; thus only highly motivated teachers will be represented.

3. The project addresses water quality issues relating to watersheds, not other
environmental issues.

4. The instrument was not originally designed to be used as a pre/post type survey.

5. Students participating in the project were not representative of the heterogeneous school
population because they volunteered to participate, and are made up largely of students
from an Advanced Biology class at Sheboygan South High School. Due to the fact that these
students chose to participate they may not be representative.

6. The sample sizes for both groups were not the same, and were small, both being under
20.
Definitions

1. **Awareness** shall mean exposing students to different riverine environments and different land uses associated with those environments. This will allow students to receive and discriminate among stimuli; to process refine, and extend those perceptions; and to concurrently acquire an aesthetic sensitivity to many different riverine environments (Engleson and Yockers, 1994).

2. **Citizen Action Behavior** shall mean students conduct with respect to environmental issues.

3. **Citizen Action Skills** shall mean providing students strategies and techniques for solving problems in rivers and other natural environments. This would include identifying an issue, collecting and analyzing data on an issue, and making suggestions for resolution of the issue. In this case, the issue will pertain to water quality of the Sheboygan River Watershed.

4. **Control group** shall mean randomly selected students from Advanced Chemistry, Physics, and Sophomore Biology classes as Sheboygan South High school.

5. **Knowledge** shall mean teaching students the basic physical, chemical, biological, and ecological concepts required for understanding the workings of rivers and watersheds. Additionally, instruction of human land uses pertinent to river water quality.

6. **Maywood Environmental Park** shall mean a city of Sheboygan park which emphasizes environmental education for the citizens of the Sheboygan area.

7. **Project** shall mean the *Testing the Waters of the Sheboygan River Project* described in this paper.
8. **Q-Tests** see “Testing the Water Project” definition, number 9.

9. **Testing the Waters Project** shall mean a program designed by the GREEN project (Mitchell and Stapp, 1996), where students monitor water quality of a river site using nine different chemical, physical, and biological tests called Q-tests, as well as using macroinvertebrate indexing and land use surveys. The Q-tests are weighted and indexed so that one index value can be derived for each site monitored, thus the data can be easily compared.

10. **Treatment group** shall mean students from Sheboygan South’s Advanced Biology class and Environmental Club who participated in the project.

11. **Values** shall mean student awareness of their own and others’ attitudes toward rivers and other natural environments.
Assumptions

1. Sheboygan County students are currently neither well informed about, nor active in resolving water quality problems and issues, especially in terms of human land use impacts.

2. Sheboygan High School students have not had education in action skills and experiences as they pertain to issues involving local rivers.

3. Different teachers involved, will provide similar levels of instruction to their participating students.

4. The need exists in Sheboygan County for environmental monitoring of the Sheboygan River Watershed.

5. The survey instrument provided a valid measure of the following environmental education goals: knowledge, values, and citizen action skills.

6. Testing the Waters programming can influence the student variables being measured.

7. The students who participated in the survey answered the items to the best of their ability.
Review of Prior Research and Work in this Area

Brief History of the Sheboygan River Watershed and the Sheboygan County Testing the Waters Project

The Sheboygan River Watershed has a history of being a beneficial resource to the residents of Sheboygan County and those who utilize Lake Michigan. Some of these benefits include recreation, flood control, and wildlife. One of the goals of the Wisconsin Department of Natural Resources Sheboygan River Remedial Action Plan (RAP), is to “enhance recreational uses of the watershed” (Maack et al., 1989). In the past ten years, the watershed has received much attention and funding. According to Maack, the Lower Sheboygan River and harbor has been identified as an Area of Concern where there is an impairment of the beneficial uses of the water resources as a consequence of the introduction of pollutants. These pollutants include polychlorinated biphenyls, heavy metals, phosphorus, nitrogen, suspended solids, and fecal coliform. Examples of impaired uses that have resulted include: degradation and loss of habitat, dredging restrictions, reduced swimming opportunities, and accelerated eutrophication.

In response to the need for community education and action, the “Testing the Water of the Sheboygan River Watershed” project was created in 1994. It was initiated by a group of secondary school teachers in the county with the assistance of Wisconsin DNR education contact, Al Stenstrup. The project had three goals at it’s inception: 1. To provide training for teachers and students so the Sheboygan River project could be implemented. 2. To establish a network of middle and high school data collecting teams in the Sheboygan River Watershed. 3. To develop and distribute a teacher guide that describes all facets of the program.

During the school year of 1996-97, none of the primary goals of the project were being met. Thus the need for revising and infusing new ideas was needed so that the goals from 1994 could be attained.
This project will utilize the Field Manual for Water Quality Monitoring (Mitchell and Stapp, 1996), which is the foundation of the Global Rivers Environmental Education Network (GREEN project). The manual’s purpose is to assist citizens in the development of attitudes, knowledge, and skills essential in helping to maintain and improve the water quality of rivers throughout the world (Mitchell and Stapp, 1996). Research has shown that teaching strategies which incorporate students’ direct involvement such as laboratory experiences in science courses enhance student attitude toward the subject matter and increase retention of knowledge (Wise and Oakey, 1983). Lisowski and Disinger (1991), found that field-based instruction in the sciences are effective in assisting students’ understanding and retention of selected ecological concepts. Research supports that field-based instruction, such as the type described in the GREEN project manual, improves students’ attitudes with respect to the environment. Also, knowledge of the concepts and issues being studied are retained at a higher rate than with traditional instruction.

The strength of the GREEN project, Testing the Waters curriculum and field manual is that they focus on water quality issues that are of local concern to the participants. The Wisconsin D.P.I. Guide to Environmental Education (Engleson and Yockers, 1994), not only states that citizen action skills and experiences are two objectives of EE in Wisconsin, but that they should be emphasized at the secondary level, which is the target student group in this project. Issue investigation, as outlined in GREEN, exposes learners to environmental action skills and a true environmental action experience for students.
Changing student behavior through environmental monitoring projects.

Environmental monitoring projects are very unlike typical EE curricula, which research indicates are not well suited to changing student attitudes or learner behavior in regards to the environment (Thompson and Gasteiger 1985; Hungerford and Volk 1990). Traditional EE programs fail to develop ownership and empowerment in learners. When students conduct monitoring projects they must take ownership in the data collection process and analysis of the data, and present their findings to community members. Further, when the project is taken a step further as is done in the GREEN project (Mitchell and Stapp 1996), students, teachers and community members team up to devise actions to raise the quality of the riverine and associated environments. This problem solving exercise gives every participant involved a sense of empowerment.

Behaviors will change when people are given the opportunity to develop a sense of "ownership" and "empowerment" so that they become fully invested in an environmental sense and are prompted to become responsible and active citizens (Hungerford and Volk 1990). It appears that environmental monitoring projects, if taken to the point of action, are an excellent issue based activity that will likely change learner behavior.

Evaluating EE Learning Experiences.

Bennet (1988), outlines four steps that need to be taken for evaluation of EE learning experiences. Step one is setting expectations, these should start with a goal supported with student objectives. Behavioral objectives can be written for knowledge, thinking skills, values, and action skills. Thus, it is possible to evaluate the program in terms of the Wisconsin D.P.I. goals and objectives for EE (Engleson and Yockers 1994).

The second step is to plan the evaluation; this establishes the overall organization and timing of the evaluation. Evaluation design and instrument development fall under this step.
The third step is to determine the results; this includes collecting, summarizing, analyzing and interpreting data. The last step is to use the results for program improvement. Results of the evaluation should be examined in light of a program's rationale, goals, and objectives. Changes can then be made at these fundamental levels, so that the overall program can be improved.
Methodology and Timeline

Data

Evaluation of the Sheboygan County Testing the Waters project was done primarily using a pencil and paper test given to students. The evaluation design was a pre/post-test with treatment and control students from Sheboygan South High School taking the test. Variables measured included student environmental values, behavior, knowledge, and citizen action skills. Students taking the test who were not involved in the project served as a control group. Using quantitative measures such as mean, median, and mode; pre and post tests were examined to determine changes in student scores between pre to post test. Additionally, the treatment group was compared to the control group to be more certain that the effects observed were a result of the program.

Research Methodology

This project will utilize quantitative methods. The quantitative methodology included collecting basic numerical data from test results. These results were analyzed to detect trends, relationships, and attainment of project goals. A pre/post-test control group design was used to test the attainment of project objectives.

Treatment of Subproblems and Timeline

Recruit and maintain teachers and community members that may participate in the Testing the Waters Project.

All teachers who have participated in the past were contacted at the start of the 97-98 school year. Schools that were not participating, but were within Sheboygan county were contacted through the school’s EE liaison contact person and/or the science department chairperson. August 97
A student/teacher orientation to the Sheboygan County Testing the Waters project was conducted on September 18, 1997. The orientation consisted of three parts: 1) land use education, 2) introduction and practice of the nine water quality “Q-value tests” and using benthic macroinvertebrates to assess water quality, and 3) discussion of action project strategies and possibilities. Community members and professional scientists were contacted to assist in the orientation. September 18, 1997

The project culminated for the school year in a student/community forum, where students presented their water quality data, their analysis of that data, and recommendations for action, or actions taken to maintain or improve the water quality of the watershed area they had been monitoring. Students from each participating school reported findings to students and teachers of the other participating schools and to members of the community attending the forum. May 5, 1998

Establishment of clear goals and objectives for the project

A meeting for all involved teachers was held on August 28, 1997. The purpose of the meeting was to briefly review and discuss the rationale, goals, and objectives for the Sheboygan Testing the Waters project. Also, the student/teacher orientation field day at Maywood Environmental Center was discussed. Last, expectations for participating schools were determined and agreed upon. August 1997

Locating a suitable instrument for use in the survey of control and treatment groups.

Research was done to determine whether or not it would be necessary to develop a new survey instrument or if one already existed that would be suitable for use in this project. A survey had been put together by the Wisconsin Center for Environmental Education (WCEE) in 1996 that questioned students’ values, behavior, and knowledge as they relate to EE. This instrument was used in this project with some modifications.
The paper and pencil survey was designed to measure student performance relating to the objectives of the Sheboygan Testing the Waters project. Objectives related to student values, behavior, knowledge, and citizen action skills. Items from the 1996 WCEE survey that best measured knowledge, values, and citizen action skills objectives were selected and used on the survey developed for this project.

Identification of treatment and control group of students

Surveying students using the pre-post survey was discussed with participating teachers at the August 28, 1997 meeting. At this time teachers were asked to identify a control group with similar characteristics of the treatment population. Further, they were asked to administer the survey and bring back the answer sheets to the September, 1997 meeting.

August/September 1997

Administration of the pre/post survey to the treatment and control groups and interpretation and comparison of the data.

The pre-survey was administered to both the treatment and control groups in September, 1997. The surveys were proctored by the teachers of the class in which the students were taking the survey. September 1997

The survey instrument was again administered to both groups of students the second week of May, 1998. Upon completion of the surveys, they were collected and scored. Data were then analyzed to determine the mean of values and behavior data based upon a likert scale of 1 to 5. The knowledge and action skills questions were graded on a percentage correct basis with mean percent scores determined. After calculating the mean scores, means were studied to determine if there were any comparative increases or decreases which would be of educational interest. Further analysis of the data helped in assessing the strengths and weaknesses of the Testing the Waters Project. May, 1998
Results

Recruit and maintain teachers and community members that may participate in the Testing the Waters Project.

All teachers who had participated in the Testing the Waters Project in the past were contacted by letter in August of 1997. All middle and high schools in Sheboygan County were also contacted and invited to participate in the project by a letter sent to the school's EE liaison or principal.

On September 18, 1997 a student/teacher orientation was conducted. The orientation consisted of three parts: 1) land use education, 2) introduction and practice of the nine water quality "Q-value tests" and use of benthic macroinvertebrates to assess water quality, and 3) discussion of citizen action skills and potential action projects.

Many community members were contacted by letter and phone to assist and support the project. Community members who assisted at the orientation consisted of the following: Dave Kukuc and Tom Finley-staff members of Maywood Environmental Park; Steve Gularneu, Tom Aartela, and Pam Packer from the Wisconsin Department of Natural Resources; Eric Fehlhaber of the Sheboygan County Land Conservation Department; Kevin Ferminich-Sea Grant Institute at U.W. Manitowoc; and Steve Rowe-Krumdick of Rust Environmental and Infrastructure of Sheboygan.

The project culminated for the school year in a student/community forum, where students presented their water quality data, their analysis of that data, and recommendations for action, or actions taken to maintain or improve the water quality of the watershed area they had been monitoring. Students from each participating school reported findings to students and teachers of the other participating schools and members of the community attending the forum. Pam Packer, Eric Fehlhaber, Steve Rowe-Krumdick, Steve Gularneu and a reporter from the Sheboygan Press were in attendance at the forum as well as the participating teachers and students.
Establishment of clear goals and objectives for the project

A meeting to orient participating teachers was held on August 28, 1997. Existing rationale, goals and objectives of the Testing the Waters Project were discussed and agreed upon. (See Appendix E for a copy of rationale, goals, and objectives of the project.) Also, a schedule for the student/teacher orientation field day at Maywood Environmental Center was set. Last, expectations for participating schools were determined and agreed upon. These expectations included that at least two test dates be conducted at each school. These test dates would be conducted once in the Fall and once in the Spring, using all nine Q-value tests. Testing dates were to be conducted on the second Thursday of the month so that schools could easily compare data.

Locating a suitable instrument for use in the survey of control and treatment groups.

Research was done to find examples of surveys that had already been constructed. The survey that best met the objectives of the project was the “Wisconsin High School Environmental Survey” put together by Phyllis Peri of the Wisconsin Center for Environmental Education, 1996. Due to differences in the Testing the Waters project, modifications were made to the survey instrument. The original survey was designed to survey students on a broad range of environmental issues, whereas the revised survey was used to survey students on environmental issues relating to aquatic environmental issues. (See Appendix A and B for a copy of both the original and revised versions of the survey.)

Deleted from the original version of the survey included a five question introductory section on personal background. Further, the revised survey consisted of only fifteen questions relating to student EE values whereas the original had thirty. The original version of the survey contained sixteen items surveying student EE behaviors, the revised version contained ten of these items. The last revision involved the knowledge and action skills questions. The original consisted of forty-eight of these questions, while the revised consisted of fifteen questions from
the original survey and five questions created specifically for this project.

These newly created questions were specific knowledge and process questions relating to knowledge, process and analysis skills directly relating to the Testing the Waters project. Questions were selected from the original survey on the basis of their relevance to the Testing the Waters project. Thus, primarily more aquatic ecology knowledge questions were included in the survey.

Identification of treatment and control group of students

Testing students using the pre-post test was discussed with teachers at the August 28 meeting. At this time it was determined that administering the survey instrument to all students involved in the project would be difficult due to consistent identification of control groups at all schools involved. Several schools and teachers were involved in the project. Students involved in the program were of different ages and involved in the project for different reasons. Therefore, it was difficult to identify a consistent control group at all schools. Thus an initial treatment group of 19 students and a control group of 15 students, all from Sheboygan South High School, were identified.

The treatment students were active participants in Sheboygan South’s Testing the Waters Project. These students consisted of seven volunteers from the South High Environmental Club and twelve students from South High Advanced Biology classes who were interested in participating in the project. The treatment group consisted of 12 females and 7 males in grades ten through twelve. The control group consisted of randomly selected students; ten from Advanced Chemistry, Physics, and five students enrolled in Sophomore Biology classes at South High. Students from advanced classes were selected to match those from the Advanced Biology class. Students from the Sophomore Biology class were selected to match those who volunteered from the environmental club. The control group consisted of six females and nine males in grades ten through twelve.
Administration of the pre/post survey to the treatment and control groups and interpretation and comparison of the data.

The pre-survey was administered to both the treatment and control groups at South High in early September, 1997. The surveys were proctored by the teachers of the class in which the students taking the survey were in. The survey instrument was again administered to both groups of students the second week of May, 1998.

As can be seen in Table 1, for both pre and post survey, the treatment group scored higher in most categories: values, behavior, action skills and knowledge. The only exceptions were behavior and action skills pre test scores. Behavior pre survey scores for the control group was 2.49 compared to 2.38 for the treatment group. Action skills pre survey scores were 0.76 for the control group and 0.67 for the treatment group.

Tables 2 and 3 show differences in pre survey mean likert scores for all categories; values, behaviors, knowledge and action skills. Differences in pre survey scores were 0.32 for values and 0.11 for behaviors, both based on 1 to 5 Likert scale, and 0.22 for knowledge and 0.09 for action skills, the latter two categories based on a percentage of items correct. From these data it can be seen that the treatment group scored higher initially in two categories: values and knowledge, the control group scored higher in the other two categories: behavior and action skills. Table 4 compares the post survey means comparison of environmental values and behavior. Table 5 makes the same post survey comparison for environmental knowledge and action skills.

Tables 6 compares pre versus post data for values and behavior scores, while Table 7 compares the pre to post knowledge and action skills scores. Table 8 indicates the percentage change from pre to post survey for values, behavior, knowledge, and action skills questions. From these tables, it can be seen that the treatment group improved scores from pre to post for all four categories: values 0.08, behavior 0.11, knowledge 0.25, and action skills 0.11. The control group went down in three of the four categories: values -0.015, behavior -0.04, knowledge 0.22, and action skills -0.33.
Mean scores of all individual questions from the survey, both pre and post, for all four categories can be seen in Appendix I.
Table 1
COMPARISON OF PRE/POST SURVEY MEAN SCORES

<table>
<thead>
<tr>
<th></th>
<th>Treatment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Values *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre test</td>
<td>4.06</td>
<td>3.74</td>
</tr>
<tr>
<td>post test</td>
<td>4.41</td>
<td>3.72</td>
</tr>
<tr>
<td>**Behaviors **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre test</td>
<td>2.38</td>
<td>2.49</td>
</tr>
<tr>
<td>post test</td>
<td>2.69</td>
<td>2.38</td>
</tr>
<tr>
<td><strong>Knowledge</strong>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre test</td>
<td>0.56</td>
<td>0.34</td>
</tr>
<tr>
<td>post test</td>
<td>0.76</td>
<td>0.43</td>
</tr>
<tr>
<td>**Action Skills ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre test</td>
<td>0.67</td>
<td>0.76</td>
</tr>
<tr>
<td>post test</td>
<td>0.76</td>
<td>0.51</td>
</tr>
</tbody>
</table>

* On a scale of 1 to 5: 1 = strongly disagree and 5 = strongly agree
** On a scale of 1 to 5: 1 = never and 5 = almost always
*** On a percentage scale, i.e., percentage of items correct
Table 2
PRE VALUES AND BEHAVIOR QUESTIONS MEANS COMPARISON

![Bar chart showing comparison of mean Likert scores for Values and Behaviors between Treatment and Control groups.](chart.png)
Table 3
PRE KNOWLEDGE AND ACTION SKILLS QUESTIONS MEANS COMPARISON

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Action Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Control</td>
</tr>
</tbody>
</table>

Percentage of Items Correct

0.8

0.7

0.6

0.5

0.4

0.3

0.2

0.1

0.0
Table 4
POST VALUES AND BEHAVIOR QUESTIONS MEAN COMPARISON

<table>
<thead>
<tr>
<th>Values</th>
<th>Behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Control</td>
</tr>
</tbody>
</table>

Mean Likert Score

- Values: Treatment > Control
- Behaviors: Treatment > Control
Table 5
POST KNOWLEDGE AND ACTION SKILLS QUESTIONS MEANS COMPARISON
Table 6
PRE VERSUS POST DATA FOR
VALUES AND BEHAVIOR QUESTIONS
Table 7
PRE VERSUS POST DATA FOR KNOWLEDGE AND ACTION SKILLS QUESTIONS

![Bar chart showing pre and post data for knowledge and action skills questions, distinguishing between treatment and control groups with bars for pre and post tests for knowledge and action skills.]
Table 8
PRE VERSUS POST PERCENTAGE CHANGE FOR VALUES, BEHAVIOR, KNOWLEDGE, AND ACTION SKILLS MEAN SCORES
Conclusions, Recommendations, and Implications

Recruit and maintain teachers and community members that may participate in the Testing the Waters Project.

Conclusions and Recommendations

It was concluded that cooperation from teachers of all participating schools is essential. With more schools having increasing E-mail capabilities this task should become easier for an individual organizing a similar project in the future.

A Fall orientation for students and teachers is essential if water quality data is going to be compiled and compared between schools. Having a common orientation will ensure that all students involved will have common methodologies, which is essential for accurate data comparison. The orientation should not only include training in water quality testing methodologies, but also focus on land use, action skills, and potential action strategies.

Contacting community members for assistance in the program is very time consuming. It is suggested that data bases be established so that rapid mailings can be generated, and use E-mail communications whenever possible. E-mail provides rapid and personal communication which is important when coordinating a single day program such as an orientation because dates, times, and tasks may change and can be communicated rapidly by E-mail.

A culminating activity such as a student/community forum is highly recommended to end the testing year. This forces the students to review their year of data collection, analyze, compare, and make recommendations for improving the water quality of the watershed based upon their and other schools data. It is recommended that community members be invited to observe student data and/or listen to student presentations. This provides an interchange of ideas for students and adults, as well as providing students with a sense of purpose for conducting the research on the watershed.
Environmental Education Implications

Since Environmental Education is directly tied to the local community, it is critical that involvement in Environmental Education involves a community, not just an isolated class of students. A natural feature which ties communities and regions together are watersheds. Thus using the watershed as a means for teaching students about water quality and conducting water action projects is a logical way to connect students, schools, and communities with respect to water resources.

Establishment of clear goals and objectives for the project

Conclusions and Recommendations

It was concluded that clear goals and objectives for a program such as Testing the Waters are essential as there are many teachers and community support people involved. Everyone involved needs to have a clear understanding of the goals and objectives of the program. Further expectations of participating schools and cooperating community members should be clearly stated to avoid misunderstandings. Last, teachers and community members involved in the program should discuss attainment of goals, objectives, and expectations after the year and make recommendations for improvement.

Environmental Education Implications

Goals and objectives are essential tools of the environmental educator so that progress can be measured. Also, it is important that a program is founded on sound goals if there are any questions or concerns from the community. This is especially true of a student water monitoring program as it may impact certain segments of the community. If members of the
community question the programs goals and objectives, it essential that they be readily available and defendable.

Locating a suitable instrument for use in the survey of control and treatment groups

Conclusions and Recommendations

It was concluded that using an existing environmental education survey is better than creating a new one. The existing survey that was selected had already been tested and statistically analyzed. It was necessary to revise the survey somewhat in order for it to meet the needs of the study.

The survey should be short enough to complete within a class period yet long enough to cover adequately the areas that are pertinent to the project. In this case, questions pertaining to water quality were selected more often than those dealing with terrestrial environmental issues. Further, a concise and simple survey may make teachers and students alike more willing to cooperate. Ease of scoring must also be taken into account as there will likely be many surveys to score.

Environmental Education Implications

Selection of an appropriate environmental education survey instrument is extremely important, this is because results of the survey can be used to assess the strengths and weaknesses of a project. Administering the survey at the beginning and the end of a school year provides the opportunity to measure how much students’ environmental values, behaviors, knowledge, and action skills changed over the course of the project.
Identification of treatment and control groups of students

Conclusions and Recommendations

It was concluded that an ideal control group is very difficult to identify. This is especially true in a project such as this where students from many schools, grade levels, and abilities make up the treatment group. It is best to clearly identify and define a treatment group, even if it is small, so that a suitable control group can be identified. This project used a treatment group of 19 students and a control group of 15 students for this reason.

It is also important to clearly communicate objectives and expectations of the survey to any teacher who may be administering the survey. Validity of results are dependent upon consistent proctoring of the survey.

Environmental Education Implications

The identification of a control group which is comparable to the treatment group is essential to good research. Thus, when assessing environmental education projects, care should be taken to clearly identify a suitable control group. This will lead to sound research providing a basis for environmental education to continue and substantiate its importance in education.

Administration of the pre/post survey to the treatment and control groups and interpretation of the data.

Conclusions and Recommendations

It can be concluded that some educationally significant changes occurred in environmental values, behaviors, knowledge, and action skills of the groups being tested. The
treatment group showed positive changes within all four categories, while the control group showed an increase in knowledge, small decreases in values and behavior, and a large decrease in action skills, see Table 8. From this data it can be seen that the treatment group displayed greater changes in all categories of the survey as compared to the control group.

The knowledge category showed the largest gain for both the treatment and control groups. The treatment group showed an percentage increase of 0.25 where as the control group showed a gain of 0.22, see Table 8. These gains indicate that environmental knowledge was gained over the course of the school year by both groups of students. The control group was made up of Advanced Chemistry and Physics, as well as Sophomore Biology students, and because there are some environmental education objectives and concepts covered in these courses, these students showed a strong increase in the knowledge component of the survey. The treatment group’s increase can be explained partially by the factors described for the control group, but the additional increase could be explained by the involvement in the Testing the Waters Project.

The environmental values and behavior categories both showed similar pre to post percentage change patterns between the treatment and control groups. In the values category, the treatment group gained 0.08 while the control group dropped a very small amount of -0.015, see Table 8. The behavior category for both groups showed similar changes: an increase of 0.11 for the treatment group and a decrease of -0.04 for the treatment group, refer to Table 8. Although both the gains for the treatment group and losses for the control group are small, these data indicate that there were positive changes in student environmental values and behavior as a result of involvement in the Testing the Waters Project. Changes in the treatment group may be a result of the nature of the Testing the Waters project; active participation in a real world problem solving activity - monitoring the water quality of the Sheboygan River. Student’s active involvement may have lead to positive change in their values and behavior toward the environment.

When examining the pre survey mean likert scores in Table 2, it can be seen that both treatment and control groups score higher in the values category than in the behaviors category.
This is not surprising when considering that changing behavior requires much more work and commitment on the part of the individual student than just changing one's values towards the environment. This difference between student value and behavior scores still remains in the post survey scores, see Table 4. Thus, the Testing the Waters project did positively change treatment students scores for both environmental values and behavior, it did not decrease the difference between the two categories.

The environmental action skills category increased by a percentage of 0.11 in the treatment group and decreased -0.33 in the control group, see Table 8. The large decrease in the control group is troubling because it indicates that these survey questions may not be measuring accurately student action skills. Supporting this idea is that there were only six action skills questions on the survey, see Action Skills Mean % Comparison Table in Appendix I. This number of questions may be too small in number to accurately measure students' environmental action skills.

A different explanation of the action skills data is that the control group students initially had strong environmental action skills, but because these skills were not taught in their regular education courses, the students did not retain these skills from the pre survey to the post survey. If this second explanation is true, it can than be assumed that the treatment group's positive gain of 0.11 is a result of involvement in the Testing the Waters project. One of the objectives of the Testing the Waters project is for students to become involved in an action project involving the Sheboygan River, thus an increase in environmental action skills would indicate that these treatment students retained action skills which were presented during the project.

Environmental Education Implications

From the results of the survey it is clear that the control group did not improve in environmental values, behavior, and action skills during the school year. There was an increase in knowledge scores. This implies that regular education courses may be increasing student's
knowledge about environmental issues, but is not addressing the equally important areas of environmental values, behavior, and action skills.

An environmental monitoring project such as the Sheboygan County Testing the Waters Project provides a community based action project which involves students addressing and solving real world environmental issues. The increase in all four categories, environmental values, behaviors, action skills, and knowledge highlights the difference between regular education and environmental monitoring projects: students involved in monitoring not only show an increase in retention of environmental knowledge, but also modest increases in environmental values, behavior, and action skills. These modest increases were not found in the control group of students.
Summary

During the 1997-98 school year, an analysis of pre and post environmental survey data showed that students involved in the Sheboygan South High School Testing the Waters project showed greater gains in environmental values, behavior, knowledge, and action skills than did a similar control group of students from Sheboygan South. The control group showed an increase in environmental knowledge and a decrease in environmental values, behavior, and action skills.

The project participants’ strong scores may be attributed to the nature of the project: one in which not only environmental knowledge content is taught, but also the objectives of environmental values, behaviors, and action skills. These objectives are attained by involving students in a community based environmental monitoring project, with the goal that students will eventually take positive environmental action in regards to the Sheboygan River Watershed.

The increase in the control group’s environmental knowledge scores can be explained by the environmental education content taught in the regular education classes at South High School. The decrease in environmental values, behavior, and action skills indicates that these objectives and skills are not being retained by methods in the regular education setting at Sheboygan South High School.

It is clear that students participating in environmental monitoring projects posses only slightly more environmental knowledge than similar students not involved in such a project. However, students involved in the project posses a much higher level of environmental values, behaviors and action skills.
References Cited


APPENDICES
APPENDIX A

Original Version of the Environmental Survey
Instructions for taking the survey:

Today you will be taking a survey that asks questions about what you know, think, and do about the environment and environmental problems. Please answer the questions truthfully and to the best of your ability.

You should have received this survey booklet and an answer sheet for recording your answers. First, using a number 2 pencil, write the first initial of your last name and your entire first name in the spaces provided on the answer sheet and darken the corresponding circles below each letter of your name.

Next, go to the section on the answer sheet marked special codes. Write the number that your teacher will give you in the space marked special codes and darken the appropriate circles under each number.

It is very important to fill in the answer sheet carefully using the number 2 pencil. Fill in only one bubble on the answer sheet for each question asked. When filling in your answer, make sure that you completely darken the circle for your choice on the answer sheet. If you make any changes in your answers, be sure to completely erase your first answer. Do not make any stray marks outside the circles.

There are four sections in the survey. Each section is different, so please read the directions carefully before starting each section. Complete the entire survey and then stop -- you do not need to stop between sections.

If there are any questions about these directions, please ask them now. You may begin the survey.
Section One

Instructions for Section One: Fill in the circle on your answer sheet for the letter of the answer that best indicates your response to each of the following questions.

1. What is your gender?
   a) female
   b) male

2. Compared to other subjects you study, how do you feel about studying environmental topics?
   a) less interested
   b) about the same
   c) more interested

3. Compared with other students your age, how well do you think you understand issues related to the environment?
   a) above average
   b) average
   c) below average

4. What one thing has contributed most to your understanding of the environment and environmental issues? (choose only one answer)
   a) school
   b) books, newspapers, or magazines I have read on my own.
   c) friends or family members (including parents)
   d) field trips, special programs or activities such as clubs, scouting or 4H
   e) television programs

5. What are your educational plans after high school?
   a) no future educational plans at the present time
   b) vocational/technical school
   c) college or university
   d) military
   e) undecided
Section Two

Instructions for Section Two: Please indicate how you feel about each statement below. There are no right or wrong answers. Read each statement carefully. Fill in the circle on your answer sheet for the letter that best indicates the extent to which you agree or disagree with each statement, using the following key:

- strongly agree (a)
- agree (b)
- no opinion (c)
- disagree (d)
- strongly disagree (e)

I enjoy watching TV programs about nature.

When I am outside, I usually don’t notice the natural things around me like flowers, trees, and clouds.

I’m not interested in reading about nature or the environment.

I like hearing the sound of animals such as birds and insects calling when I’m outside.

I think most of the concern about environmental problems has been exaggerated.

Knowing about environmental problems and issues is important to me.

A community’s pollution regulations should not interfere with industrial growth and development.

I am concerned about the issue of deforestation.

I think that damage to the ozone layer is something that everyone should be concerned about.

More controls should be placed on industry and agriculture to protect the quality of the environment, even if it means that things that I purchase will cost more.

I am not concerned about the fact that the world’s deserts are increasing in size.

There are already enough laws to protect the environment.
18. I believe that plants and animals exist to be used by humans.
19. I don't think that recycling is worth all the trouble it takes.
20. I would oppose any environmental regulations that would restrict my way of life.
21. More land should be set aside for wildlife habitats.
22. Environmental restrictions should be lifted so that exploration and production of fossil fuels can be increased.
23. If a person's car exceeds certain standards for air pollution, he or she should not be allowed to drive it.
24. The government should provide financial support for research and development related to renewable energy, even if it means that taxes will be higher.
25. I am concerned about how much waste is produced in this country.
26. Laws should be passed and enforced that protect the quality of life in the future even if it means that individual freedoms are limited.
27. I am not concerned about the rate of species extinction in the world.
28. I am concerned about environmental health hazards such as those caused by air or water pollution.
29. I want to help solve environmental problems.
30. There is not much that I can do that will help solve environmental problems.
31. I believe that I can contribute to the solution of environmental issues by my actions.
32. It's too hard to change my friends' minds about doing things to help the environment (for example, recycling).
33. An individual, working on his or her own, can contribute to the solution of environmental problems and issues.
34. Things that I do don't have much effect on the quality of the environment.
35. I feel that it is my responsibility to help solve environmental problems.
Section Three

Instructions for Section Three: For the following group of statements, please indicate how frequently you do each of the actions mentioned. Be honest, there are no right or wrong answers. Fill in the circle on your answer sheet for the letter that is closest to your answer, using the following key:

almost always (a)
often (b)
sometimes (c)
almost never (d)
never (e)

I turn off lights and appliances when they’re not being used in order to conserve electricity.

I avoid purchasing products that are over-packaged.

I talk to people that I notice doing something that harms the environment in an effort to persuade that person to stop that activity. (For example, try to talk a friend into recycling pop cans instead of throwing them in the trash.)

I walk, take public transportation, or ride a bike instead of using a car in order to help protect the environment.

I make an effort to reduce the amount of goods I consume.

I set a positive environmental example for my friends to follow.

I support candidates for school offices who are concerned about environmental problems and issues in our school.

If I see an aluminum can on the ground when I’m out walking, I pick it up and take it with me.

I recycle paper, glass, and/or metal waste products at home or at school.

I avoid purchasing products that have a negative impact on the environment.

I talk to my family and friends about what they can do to help solve environmental problems.

I write or call politicians to express my views about environmental issues.
48. I make a point of reading newspaper and magazine articles about the environment.

49. I purchase one product over another product because it is packaged in reusable, returnable, or recyclable containers or packages.

50. I send letters to the newspaper about environmental problems or issues.

51. I have reported environmental problems or violations that I have noticed to the proper authorities.

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Section Four

Instructions for Section Four: For each of the following questions, choose the best answer. Fill in the circle for the letter of the answer on your answer sheet.

2. A food web consists of
   
   a) the animals that eat other animals in a community.
   b) all the herbivores and carnivores in an ecosystem.
   c) many interconnected food chains.
   d) all the consumers in an ecosystem.

3. When two or more species attempt to use the same limited resource in an ecosystem, their interaction is called
   
   a) mutualism.
   b) competition.
   c) predation.
   d) commensalism.

4. Having sharp thorns can help a plant by keeping animals from eating it. This is an example of
   
   a) mutualism.
   b) adaptation.
   c) competition.
   d) commensalism.
5. All of the individual organisms that live on the ground in a particular forest share the same
   a) niche.
   b) habitat.
   c) life-style.
   d) food source.

6. The reason dead leaves and twigs don't build up in a forest from year to year is because
   a) non-living elements such as wind and rain remove them.
   b) decomposers break them down into soil.
   c) animals eat them or use them to build nests.
   d) none of the above.

Wolves often eat deer. Does this interaction have any beneficial effects on the deer population as a whole?
   a) Yes, the wolves help keep the deer population size controlled.
   b) No. The deer population is usually only harmed.
   c) Yes, the wolves help keep the deer population strong since the fastest, most alert deer survive.
   d) both (a) and (c)

The energy currently present
   a) is all the energy we will ever have.
   b) can change form but is never destroyed.
   c) can only be used once.
   d) is mostly in the form of fossil fuel energy.

Based upon major ecological principles, we should conclude that
   a) humans are a climax species that will last indefinitely.
   b) the human species will soon become extinct; nothing we can do will prevent this.
   c) the human species will last as long as there is a balanced ecosystem that will support human life.
   d) there is no way of predicting what will happen to the human species; ecological principles do not apply to humans.
60. The process of photosynthesis in green plants
a) uses sunlight to burn energy in plants.
b) changes light energy into chemical energy.
c) changes chlorophyll into sugar.
d) is a process used to burn sugar stored in plants so the plants can grow.

61. Which of the following terms is used to describe all of the natural living and nonliving interacting features of a given area?
   a) habitat
   b) community
   c) biodiversity
   d) ecosystem

62. Humans grow crops for food. Many species of these plants need certain species of insects (such as bees) to pollinate them. The pollinating insects often rely on the nectar they obtain from the plants for food. This is a good example of
   a) how organisms, including humans, are interdependent.
   b) commensalism between humans and other species.
   c) how humans manipulate their environment.
   d) a food web that includes humans.

63. A particular aquatic ecosystem is contaminated by a chemical which tends to remain stored in body fat. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem?
   a) plant life
   b) minnows
   c) fish that eat insects and plants
   d) fish-eating birds

64. Which of the following phrases refers to the potential ability of a system to support population growth without harming the environment?
   a) carrying capacity
   b) species loading
   c) non-sustainable growth
   d) all of the above
5. In a small lake, a food chain was as follows:

\[
\text{sun} \rightarrow \text{green algae} \rightarrow \text{small crustaceans} \rightarrow \text{fish}
\]

After many months of heavy snow covering the ice, most of the small crustaceans died. What is the best explanation for this?

a) The algae population was cut off from its source of energy.
b) It was too cold for the crustaceans to survive.
c) The fish ate most of the crustaceans.
d) A disease killed most of the algae.

6. If carbon dioxide (CO₂) disappeared from the atmosphere, which of the following would be affected first?

a) plants
b) animals that eat plants
c) animals that eat other animals
d) decomposers

Each of the following food chains starts with the same amount of green plants. Assuming that the green plants are digestible by humans, which of the food chains would supply the most energy to humans?

a) green plants to humans
b) green plants to cattle to humans
c) green plants to insects to fish to humans
d) green plants to insects to small fish to larger fish to humans

Some insecticides that were once effective in killing insects no longer work very well. This is because

a) new insect species develop every day.
b) the wrong kind of insecticides were used.
c) insects with natural resistance survived and multiplied.
d) the insects produced many more offspring than the insecticide could kill.
69. Which of the food webs below would be affected the most if all of the mice were removed? (Note: the arrows point to the consumer of the organism in the food web)

Food Web (A)

- owls
- snakes
- voles
- mice
- rabbits
- plants

Food Web (B)

- owls
- snakes
- mice
- rabbits
- plants

a) food web (A)
b) food web (B)
c) Neither would be affected.
d) They would both be affected to the same degree.

70. Which of the following contributes to air pollution at the surface of the earth, and acts as a shield against ultraviolet rays in the upper atmosphere?

a) nitrous oxide
b) methane
c) ozone
d) sulfur dioxide

71. The main source(s) of emissions that have been identified as contributing to acid deposition (acid rain) in the United States are

a) volcanoes and forest fires.
b) petroleum refineries.
c) automobiles and coal burning power plants.
d) aerosol sprays and refrigerant leakage.

72. Which of the following is not true of the world’s human population?

a) It is expected to double within your lifetime.
b) It is declining in developed areas such as the United States and Canada.
c) Its increase has led to the extinction of many plant and animal species.
d) The greatest rate of population growth is occurring in developing areas such as South America and Africa.
73. The future of food production as it is currently practiced in this country is in question because

a) soil is being depleted by erosion.
b) the use of synthetic chemical additives has become an issue.
c) agricultural land is being lost to development.
d) all of the above.

74. Which of the following would be most likely to cause groundwater pollution?

a) organic farming practices  
b) municipal composting of yard wastes  
c) adding too much fertilizer to fields  
d) wastewater treatment plants

75. The rate of species’ extinction is higher now than at any time since the period of the dinosaurs’ extinction. The main cause of this rapid decline in biodiversity is

a) habitat alteration by humans.  
b) the illegal poaching or collecting of animals and plants.  
c) changes in the Earth’s atmosphere due to human activities.  
d) hunting by humans for food or sport.

76. Which of the following do scientists feel is the least important contributor to the greenhouse effect?

a) destruction of the earth’s rainforests  
b) burning of fossil fuels, such as gasoline and oil  
c) increased use of hydroelectric power  
d) production of methane gas by cattle and rice paddies

77. Most municipal solid waste in the United States is presently disposed of by what method?

a) burning it in closed incinerators  
b) recycling  
c) shipping it out to sea and dumping it  
d) burying it in landfills
78. Which of the following is **NOT** a major water pollutant?
   a) bacteria
   b) pesticides
   c) heat
   d) All of the above are major water pollutants.

79. One suggested advantage of using nuclear power plants for energy production is that
   a) nuclear power plants are not expensive to build.
   b) the waste products are fairly easy to store.
   c) there is less air pollution.
   d) they are totally safe.

80. Which of the following results in the most serious waste or loss of our usable water?
   a) contamination by bacteria
   b) uncontrolled drainage
   c) careless usage
   d) improper storage

81. Which of the following would be most likely to result in soil erosion?
   a) an increase in nutrients added to the soil
   b) the removal of vegetation
   c) contour plowing of hillsides
   d) aeration of the soil by bacteria

82. Which of the following is considered to be a non-renewable energy source?
   a) oil
   b) wood
   c) biomass
   d) none of the above
83. Which of the following is a naturally occurring, invisible gas which can seep out of the ground into people's homes and cause serious health problems?
   a) ethane  
   b) krypton  
   c) radon  
   d) chlorofluorocarbon

84. A major nuclear accident occurred in 1986 at the_______ nuclear power plant.
   a) Belgrade  
   b) Nagasaki  
   c) Chernobyl  
   d) Three Mile Island

85. Which of the following offers the most potential for reducing our immediate energy problems?
   a) geothermal power  
   b) energy conservation  
   c) biomass conversion  
   d) tidal power

86. Having your household water tested is important if
   a) you live in an old house.  
   b) your water comes from a well.  
   c) you live in an agricultural area.  
   d) all of the above.

87. Which of the following is most likely to help endangered species?
   a) Outlaw the sale or possession of endangered species or products made from them (skins, furs, ivory, etc.).  
   b) Create breeding programs in zoos for endangered animals.  
   c) Use farming methods which do not damage habitat.  
   d) Maintain large protected natural areas where they live.
88. In the long term, which of the following would be the best way to lessen the problem of solid waste?

   a) Incinerate waste materials.
   b) Reduce the amount of materials being consumed.
   c) Reuse materials for other purposes rather than throwing them out.
   d) Recycle materials that can be used again.

89. Which of the following would be the most effective method to influence a large number of people to take action about an environmental problem?

   a) Advertise on the radio.
   b) Write letters to the newspaper.
   c) Go door to door and talk to people.
   d) Use a combination of the above.

90. If your student environmental club was concerned about an environmental issue, which of the following would be the best thing to do first?

   a) Write and circulate a petition about the issue.
   b) Talk to other people about what they could do to help resolve the issue.
   c) Write to elected officials about your concern.
   d) Research the issue.

This is the end of the survey. Thank you for your participation!
APPENDIX B

Revised Version of the Environmental Survey
Part One

Instructions for Part One: Please indicate how you feel about each statement below. There are no right or wrong answers. Read each statement carefully. Fill in the circle on your answer sheet for the letter that best indicates the extent to which you agree or disagree with each statement, using the following key:

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>No opinion</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
<td>(e)</td>
</tr>
</tbody>
</table>

1. When I am outside, I usually don’t notice the natural things around me like flowers, trees, and clouds.

2. I’m not interested in reading about nature or the environment.

3. I think most of the concern about environmental problems has been exaggerated.

4. A community’s pollution regulations should not interfere with industrial growth and development.

5. More controls should be placed on industry and agriculture to protect the quality of the environment, even if it means the things that I purchase will cost more.

6. I would oppose any environmental regulations that would restrict my way of life.

7. I am concerned about how much waste is produced in this country.

8. Laws should be passed and enforced that protect the quality of life in the future even if it means that individual freedoms are limited.
9. I am concerned about environmental health hazards such as those caused by air or water pollution.

10. Knowing about environmental problems and issues is important to me.

11. I want to help solve environmental problems.

12. There is not much that I can do that will help solve environmental problems.

13. I believe that I can contribute to the solution of environmental issues by my actions.

14. An individual, working on his or her own, can contribute to the solution of environmental problems and issues.

15. Things that I do have little effect on the quality of the environment.

Part Two

**Instructions for Part Two:** For the following group of statements, please indicate how frequently you do each of the actions mentioned. Be honest, as there are no right or wrong answers. Fill in the circle on your answer sheet for the letter that is closest to your answer, using the following key:

<table>
<thead>
<tr>
<th>Almost Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Almost Never</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
<td>(e)</td>
</tr>
</tbody>
</table>

16. I walk, take public transportation, or ride a bike instead of using a car in order to help protect the environment.

17. I make an effort to reduce the amount of goods I consume.

18. I set a positive environmental example for my friends to follow.
19. I avoid purchasing products that have a negative impact on the environment.

20. I talk to my family and friends about what they can do to help solve environmental problems.

21. I write or call politicians to express my views about environmental issues.

22. I make a point of reading newspaper and magazine articles about the environment.

23. I purchase one product over another product because it is packaged in reusable, returnable or recyclable containers or packages.

24. I send letters to the newspaper about environmental problems or issues.

25. I have reported environmental problems or violations that I have noticed to the proper authorities.

Part Three

Instructions for Part Three: For each of the following questions, choose the best answer. Fill in the circle for the letter of the answer on your answer sheet.

26. Which of the following words is used to describe all of the natural living and nonliving interacting features of a given area?
   a) habitat
   b) community
   c) biodiversity
   d) ecosystem
27. A particular aquatic ecosystem is contaminated by a chemical which tends to remain stored in body fat. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem?
   a. plant life
   b. minnows
   c. fish that eat insects and plants
   d. fish-eating birds

28. Which of the following is **NOT** a major water pollutant?
   a. bacteria
   b. pesticides
   c. heat
   d. All of the above are major water pollutants.

29. Which of the following would be most likely to result in soil erosion?
   a. an increase in nutrients added to the soil
   b. the removal of vegetation
   c. contour plowing of hillsides
   d. aeration of the soil by bacteria

30. Which of the following would be the most effective method to influence a large number of people to take action about an environmental problem?
   a. Advertise on the radio.
   b. Write letters to the newspaper.
   c. Go door to door and talk to people.
   d. Use a combination of the above.

31. If your student environmental club was concerned about an environmental issue, which of the following would be the best thing to do **first**?
   a. Write and circulate a petition about the issue.
   b. Talk to other people about what they could do to help resolve the issue.
   c. Write to elected officials about your concern.
   d. Research the issue.
32. The water cycle of the Earth is also referred to as the:
   a. hydrospheric cycle.
   b. aqualogic cycle.
   c. hydrogen cycle.
   d. hydrologic cycle.

33. Runoff of fertilizer or sewage discharged into a lake could lead to fish kills because
   a. the fertilizer or sewage poisons the fish.
   b. the nutrients make algae grow and algae poisons most fish when they eat it.
   c. decomposers feeding on dead algae use the oxygen.
   d. None of the above. This situation will not lead to fish kills.

34. Soil erosion is a serious problem because:
   a. it increases turbidity in waterways.
   b. the soil cannot be replaced.
   c. eroded soil causes groundwater pollution.
   d. trees can be uprooted when the soil is washed away.

35. Which of the following would be an effective action that people could take to help reduce soil erosion?
   a. Read and do research about the problem.
   b. Increase the use of fertilizers on farms.
   c. Let the grass in their lawns grow longer before mowing it.
   d. Write to elected officials about the problem so that better legislation will be passed.

36. What is given off by animals and used by plants to make their own food?
   a. hydrogen
   b. oxygen
   c. nitrogen
   d. carbon dioxide
37. Runoff of pesticides and fertilizers into rivers and lakes causes serious problems to natural ecosystems. Which of the following would be the best way to reduce this problem?
   a. Ban the use of chemicals in agriculture and gardening.
   b. Educate people about how to use these products.
   c. Improve farming practices.
   d. Make more powerful pesticides and fertilizers so that smaller amounts can be used.

38. Runoff of polluted water from streets, highways and parking lots into city water systems causes serious water quality problems. Which of the following would be the best way for you to help reduce this problem?
   a. Take public transportation, walk, or ride your bike to school.
   b. Pour used motor oil into the ground rather than into a street drainage gutter.
   c. Use unleaded gasoline in your car.
   d. Help keep the driveways and sidewalks clean around your neighborhood.

39. Which of the following best describes the relationship between the number of different kinds of organisms in an ecosystem and ecosystem's stability?
   a. There is no relationship.
   b. The larger the number of species of organisms, the greater the stability.
   c. The smaller the number of species of organisms, the greater the stability.
   d. Too small or too large a number of species of organisms will lower the stability.

40. Where would be the best place to gather current research information about a particular environmental problem?
   a. encyclopedias
   b. textbooks
   c. TV news shows
   d. journals or magazines
41. When found in aquatic ecosystems, the nitrogen and phosphorus compounds in untreated sewage:
   a. are produced by bacterial action.
   b. stimulate the growth of plants.
   c. suffocate organisms in the water.
   d. use most of the available oxygen.

42. Organisms such as stoneflies and caddisflies that require large amounts of oxygen would be found in what section of a river?
   a. backwaters
   b. riffles
   c. runs
   d. pools

43. Use the figure below to determine the % oxygen saturation of a water sample that has a dissolved oxygen level of 11.5 parts per million and a temperature of 8 C.
   a. 
   b. 
   c. 
   d. 

44. Of the following water quality tests which would be used to best indicate that there is a source of soil runoff nearby in the stream?
   a. dissolved oxygen
   b. turbidity
   c. temperature
   d. nitrates
45. Of the following water quality tests which would be used to best indicate that there is a source of raw sewage runoff nearby in the stream?
   a. fecal coliform
   b. temperature
   c. dissolved oxygen
   d. total solids
APPENDIX C

List of Schools and Teachers Involved in the Testing the Waters Project
List of Schools and Teachers Involved in the Testing the Waters Project

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APPENDIX D

List of Support Professionals Involved in the Testing the Waters Project
List of Support Professionals Involved in the Testing the Waters Project

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APPENDIX E

Map of Sheboygan River Watershed
The Sheboygan River Basin

Legend
- WWTP
* Sample Site
River Basin Boundary
Stream
Highway
Open Water
Wetland
Municipal Area

Wastewater Treatment Plants
1 Belgium WWTP
2 Onion River Sewage Commission WWTP (formerly Hingham WWTP)
3 Gibbsville WWTP
4 Waldo WWTP
5 Sheboygan County Health Center WWTP
6 Mt. Calvary WWTP
7 St. Cloud WWTP
8 Kiel WWTP
9 Plymouth WWTP
10 Johnsonville Foods

Wisconsin Department of Natural Resources
BIM-Geo Services Section
July 1983

Scale 1:320,000
APPENDIX F

Rationale, Goals, and Objectives
of the Testing the Waters Project
III. Statement of Need: The Sheboygan River has been identified as one of the 43 "hot spots" for Great Lakes pollution. At the present time, there is a major effort underway to clean up PCBs in the river bed. A variety of local groups have already been working with government and industry to clean up the river. The Department of Natural Resources is working with the groups to develop a Remedial Action Plan for the Sheboygan River Watershed. Our consortium will work with our Environmental Scientist-in-Residence to jointly develop and execute a comprehensive program for the purpose of educating teachers and students about local surface water, ground water, non-point source pollution and pollution abatement issues in the Sheboygan River Watershed. With the assistance of our Environmental Scientist-in-Residence, teachers and students will work with local water quality groups to increase general public awareness and affect policies in local government and industry.

There has been no organized effort to meet this need in this watershed in prior years. This project will involve three major efforts: Staff development, curriculum and the preparation of citizens to become active participants in the resolution of local environmental issues.

IV. Project Goals and Objectives: Goal 1.0 To provide training for teachers and students so the Sheboygan River project can be implemented.

Objective 1.1: Teachers and student mentors will receive training on 1) river ecology; 2) pollution issues on the Sheboygan River; 3) intervention strategies that potential could improve water quality in the watershed.

Objective 1.2: Students will receive training in using scientific equipment properly, learn to compare and contrast water quality parameters from different points within the watershed over time, and learn about careers in environmental education from working with experts.

Goal 2.0 To establish a network of middle and high school data collecting teams in the Sheboygan River Watershed.

Objective 2.1: Students from each team will learn how to collect the data.

Objective 2.2: Students will learn how to work with other groups on solving our environmental problems in the watershed.

Goal 3.0 To develop and distribute curriculum materials.

Objective 3.1: A teacher guide will be developed and distributed that will include all facets of this program.
EVALUATION OF THE EXTENT TO WHICH A STUDENT RIVER MONITORING PROGRAM IN SHEBOYGAN COUNTY, WI, INFLUENCES STUDENT'S VALUES, BEHAVIORS, KNOWLEDGE, AND ACTION SKILLS REGARDING ENVIRONMENTAL EDUCATION AND AQUATIC ECOLOGY

By
Brian H. Henriksen

A Research Proposal Submitted in Partial Fulfillment of Masters of Science in Environmental Education at the University of Wisconsin-Stevens Point

Approved by

Dr. Daniel Silvek, Advisor
Associate Professor of Resource Management

July 1998
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Many family, friends, and experts have contributed greatly to the success of the Sheboygan Testing the Waters Project. A special thanks goes to Dr. Dan Sivek, Environmental Education Professor at the University Wisconsin - Stevens Point, for all of his advice, guidance, and proof reading. A very special thank you to all the teachers and support professionals that participated in the Testing the Waters Project; it is your dedication that made the project work. I also would like to thank and recognize my children: Holly and Owen for their patience and understanding the past two years. Last, and most importantly, I would like to thank my wife Tina, whose constant encouragement, willingness to spend time with our children and proof reading was essential to the success of this project.
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Abstract

A student water testing project involving several schools in Sheboygan County was developed in the Fall of 1997. The major goal of the project was to prepare students to become active participants in the resolution of local environmental issues. Allowing students to investigate an environmental issue, such as river water quality at the community level, would allow students to gain the necessary experiences, knowledge, and action skills to attain this goal.

During the 1997-98 school year, students participating in the project were evaluated on the project's impacts on student's environmental values, behaviors, knowledge, and action skills using a pre/post survey. A control group of students was also surveyed using the same survey instrument. All students surveyed were from Sheboygan South High School, Sheboygan Wisconsin. Both treatment and control groups were surveyed in September 1997 and again in May 1998. Conclusions were drawn based upon comparison of the pre and post data.

The survey results indicated that the treatment group improved mean percentage scores in all four categories from the pre to post surveys. The control group only improved scores in the environmental knowledge category.

These results indicate that a student environmental monitoring program does have an impact on student's environmental values, behavior, and action skills. Environmental knowledge scores improved for both groups of students indicating that the project had a lesser effect in this category. To better attain the goal of active citizen preparation among students, projects that require active student participation, such as a student water testing project, are more effective than traditional classroom methodologies.
Introduction

Statement of the Problem

The purpose of this project is to develop a water testing project and evaluate its impacts on the values, behaviors, and action skills of students from several school districts in Sheboygan County, Wisconsin.

Subproblems

1. The first subproblem is to identify, recruit and maintain teachers and community members to participate in the water testing project.

2. The second subproblem is to set clear objectives for a program that addresses three of the Wisconsin Department of Public Instruction's (DPI) environmental education (EE) objectives. These are: student knowledge, values, and citizen action skills.

3. The third subproblem is to locate a suitable instrument for use in the survey of control and treatment groups.

4. The fourth subproblem is to identify a control group of students against which to compare the treatment group with regards to environmental knowledge, values, behaviors and citizen action skills.

5. The fifth subproblem is to administer the pre/post survey to the treatment and control groups and to interpret and compare the data.

Significance of the Problem

One of the primary goals of EE is changing student behavior "favorably" in regard to the
environment. By “favorably” it is meant that students will make decisions regarding the environment which balance the ecological needs of the environment and that of the community in which they live. This behavior should be exhibited through positive environmental actions by participants in EE programs. However, EE has produced ecologically concerned citizens who are armed with ecological myths, but lack the knowledge and conviction of their own role in environmental problems (Gigliotti, 1990), and lack the skills needed to take appropriate action in regards to the environment.

When considering the Wisconsin DPI objectives, student values, action skill development and action experiences are recommended areas of emphasis at the senior high level (Engleson and Yockers, 1994). Analysis of teaching objectives with respect to EE at this level suggests that most EE occurs at the attitudes and knowledge level, even in the secondary grade levels (Lane, 1993). Teaching strictly knowledge is problematic because it does not change learner environmental behaviors (Thompson and Gasteiger, 1985). Even worse, ecological knowledge is not retained well when only knowledge objectives are taught (Arcury and Johnson, 1986). This problem can be explained by the traditional thinking in the field of EE, which has been that behavior can be changed by making students more knowledgeable about the environment and its associated issues (Hungerford and Volk, 1990).

Current literature indicates that issues must be the focus of instruction, and that students must be given the opportunity to develop the sense of “ownership” and “empowerment” that a successful action experience provides (Hungerford and Volk, 1990). These are essential for learner behavior change to occur. In a broader sense, the techniques that have resulted in consistent behavior change are antecedent conditions, commitment, modeling, and goal setting strategies (Dwyer and Lemming, 1993). Long term environmental monitoring projects, such as river water testing, provides students, teachers and community members the type of long term, issue oriented project that research has shown is more likely to change participant behavior. Further it requires participants to set new goals while drawing from antecedent conditions, which Dwyer and Lemming (1993) indicate are critical to changing
Learner behavior.

Limitations

1. The project will be limited only to students from Sheboygan County; thus results will be generalized only to those schools participating.

2. The project will not require participation of teachers lacking an interest in the program; thus only highly motivated teachers will be represented.

3. The project addresses water quality issues relating to watersheds, not other environmental issues.

4. The instrument was not originally designed to be used as a pre/post type survey.

5. Students participating in the project were not representative of the heterogeneous school population because they volunteered to participate, and are made up largely of students from an Advanced Biology class at Sheboygan South High School. Due to the fact that these students chose to participate they may not be representative.

6. The sample sizes for both groups were not the same, and were small, both being under 20.
Definitions

1. **Awareness** shall mean exposing students to different riverine environments and different land uses associated with those environments. This will allow students to receive and discriminate among stimuli; to process, refine, and extend those perceptions; and to concurrently acquire an aesthetic sensitivity to many different riverine environments (Engleson and Yockers, 1994).

2. **Citizen Action Behavior** shall mean students conduct with respect to environmental issues.

3. **Citizen Action Skills** shall mean providing students strategies and techniques for solving problems in rivers and other natural environments. This would include identifying an issue, collecting and analyzing data on an issue, and making suggestions for resolution of the issue. In this case, the issue will pertain to water quality of the Sheboygan River Watershed.

4. **Control group** shall mean randomly selected students from Advanced Chemistry, Physics, and Sophomore Biology classes at Sheboygan South High School.

5. **Knowledge** shall mean teaching students the basic physical, chemical, biological, and ecological concepts required for understanding the workings of rivers and watersheds. Additionally, instruction of human land uses pertinent to river water quality.

6. **Maywood Environmental Park** shall mean a city of Sheboygan park which emphasizes environmental education for the citizens of the Sheboygan area.

7. **Project** shall mean the *Testing the Waters of the Sheboygan River Project* described in this paper.
8. **Q-Tests** see "Testing the Water Project" definition, number 9.

9. **Testing the Waters Project** shall mean a program designed by the GREEN project (Mitchell and Stapp, 1996), where students monitor water quality of a river site using nine different chemical, physical, and biological tests called Q-tests, as well as using macroinvertebrate indexing and land use surveys. The **Q-tests** are weighted and indexed so that one index value can be derived for each site monitored, thus the data can be easily compared.

10. **Treatment group** shall mean students from Sheboygan South's Advanced Biology class and Environmental Club who participated in the project.

11. **Values** shall mean student awareness of their own and others' attitudes toward rivers and other natural environments.
Assumptions

1. Sheboygan County students are currently neither well informed about, nor active in resolving water quality problems and issues, especially in terms of human land use impacts.

2. Sheboygan High School students have not had education in action skills and experiences as they pertain to issues involving local rivers.

3. Different teachers involved, will provide similar levels of instruction to their participating students.

4. The need exists in Sheboygan County for environmental monitoring of the Sheboygan River Watershed.

5. The survey instrument provided a valid measure of the following environmental education goals: knowledge, values, and citizen action skills.

6. Testing the Waters programming can influence the student variables being measured.

7. The students who participated in the survey answered the items to the best of their ability.
Brief History of the Sheboygan River Watershed and the Sheboygan County Testing the Waters Project

The Sheboygan River Watershed has a history of being a beneficial resource to the residents of Sheboygan County and those who utilize Lake Michigan. Some of these benefits include recreation, flood control, and wildlife. One of the goals of the Wisconsin Department of Natural Resources Sheboygan River Remedial Action Plan (RAP), is to “enhance recreational uses of the watershed” (Maack et al., 1989). In the past ten years, the watershed has received much attention and funding. According to Maack, the Lower Sheboygan River and harbor has been identified as an Area of Concern where there is an impairment of the beneficial uses of the water resources as a consequence of the introduction of pollutants. These pollutants include polychlorinated biphenyls, heavy metals, phosphorus, nitrogen, suspended solids, and fecal coliform. Examples of impaired uses that have resulted include: degradation and loss of habitat, dredging restrictions, reduced swimming opportunities, and accelerated eutrophication.

In response to the need for community education and action, the “Testing the Water of the Sheboygan River Watershed” project was created in 1994. It was initiated by a group of secondary school teachers in the county with the assistance of Wisconsin DNR education contact, Al Stenstrup. The project had three goals at its inception: 1. To provide training for teachers and students so the Sheboygan River project could be implemented. 2. To establish a network of middle and high school data collecting teams in the Sheboygan River Watershed. 3. To develop and distribute a teacher guide that describes all facets of the program.

During the school year of 1996-97, none of the primary goals of the project were being met. Thus the need for revising and infusing new ideas was needed so that the goals from 1994 could be attained.
Description of EE objectives as they relate to Testing the Waters Project and other environmental monitoring projects.

This project will utilize the Field Manual for Water Quality Monitoring (Mitchell and Stapp, 1996), which is the foundation of the Global Rivers Environmental Education Network (GREEN project). The manual's purpose is to assist citizens in the development of attitudes, knowledge, and skills essential in helping to maintain and improve the water quality of rivers throughout the world (Mitchell and Stapp, 1996). Research has shown that teaching strategies which incorporate students' direct involvement such as laboratory experiences in science courses enhance student attitude toward the subject matter and increase retention of knowledge (Wise and Oakey, 1983). Lisowski and Disinger (1991), found that field-based instruction in the sciences are effective in assisting students' understanding and retention of selected ecological concepts. Research supports that field-based instruction, such as the type described in the GREEN project manual, improves students' attitudes with respect to the environment. Also, knowledge of the concepts and issues being studied are retained at a higher rate than with traditional instruction.

The strength of the GREEN project, Testing the Waters curriculum and field manual is that they focus on water quality issues that are of local concern to the participants. The Wisconsin D.P.I. Guide to Environmental Education (Engleson and Yockers, 1994), not only states that citizen action skills and experiences are two objectives of EE in Wisconsin, but that they should be emphasized at the secondary level, which is the target student group in this project. Issue investigation, as outlined in GREEN, exposes learners to environmental action skills and a true environmental action experience for students.
Changing student behavior through environmental monitoring projects.

Environmental monitoring projects are very unlike typical EE curricula, which research indicates are not well suited to changing student attitudes or learner behavior in regards to the environment (Thompson and Gasteiger 1985; Hungerford and Volk 1990). Traditional EE programs fail to develop ownership and empowerment in learners. When students conduct monitoring projects they must take ownership in the data collection process and analysis of the data, and present their findings to community members. Further, when the project is taken a step further as is done in the GREEN project (Mitchell and Stapp 1996), students, teachers and community members team up to devise actions to raise the quality of the riverine and associated environments. This problem solving exercise gives every participant involved a sense of empowerment.

Behaviors will change when people are given the opportunity to develop a sense of “ownership” and “empowerment” so that they become fully invested in an environmental sense and are prompted to become responsible and active citizens (Hungerford and Volk 1990). It appears that environmental monitoring projects, if taken to the point of action, are an excellent issue based activity that will likely change learner behavior.

Evaluating EE Learning Experiences.

Bennet (1988), outlines four steps that need to be taken for evaluation of EE learning experiences. Step one is setting expectations, these should start with a goal supported with student objectives. Behavioral objectives can be written for knowledge, thinking skills, values, and action skills. Thus, it is possible to evaluate the program in terms of the Wisconsin D.P.I. goals and objectives for EE (Engleson and Yockers 1994).

The second step is to plan the evaluation; this establishes the overall organization and timing of the evaluation. Evaluation design and instrument development fall under this step.
The third step is to determine the results; this includes collecting, summarizing, analyzing and interpreting data. The last step is to use the results for program improvement. Results of the evaluation should be examined in light of a program's rationale, goals, and objectives. Changes can then be made at these fundamental levels, so that the overall program can be improved.
Methodology and Timeline

Data

Evaluation of the Sheboygan County Testing the Waters project was done primarily using a pencil and paper test given to students. The evaluation design was a pre/post-test with treatment and control students from Sheboygan South High School taking the test. Variables measured included student environmental values, behavior, knowledge, and citizen action skills. Students taking the test who were not involved in the project served as a control group. Using quantitative measures such as mean, median, and mode; pre and post tests were examined to determine changes in student scores between pre to post test. Additionally, the treatment group was compared to the control group to be more certain that the effects observed were a result of the program.

Research Methodology

This project will utilize quantitative methods. The quantitative methodology included collecting basic numerical data from test results. These results were analyzed to detect trends, relationships, and attainment of project goals. A pre/post-test control group design was used to test the attainment of project objectives.

Treatment of Subproblems and Timeline

Recruit and maintain teachers and community members that may participate in the Testing the Waters Project.

All teachers who have participated in the past were contacted at the start of the 97-98 school year. Schools that were not participating, but were within Sheboygan county were contacted through the school's EE liaison contact person and/or the science department chairperson. August 97
A student/teacher orientation to the Sheboygan County Testing the Waters project was conducted on September 18, 1997. The orientation consisted of three parts: 1) land use education, 2) introduction and practice of the nine water quality “Q-value tests” and using benthic macroinvertebrates to assess water quality, and 3) discussion of action project strategies and possibilities. Community members and professional scientists were contacted to assist in the orientation. September 18, 1997

The project culminated for the school year in a student/community forum, where students presented their water quality data, their analysis of that data, and recommendations for action, or actions taken to maintain or improve the water quality of the watershed area they had been monitoring. Students from each participating school reported findings to students and teachers of the other participating schools and to members of the community attending the forum. May 5, 1998

Establishment of clear goals and objectives for the project

A meeting for all involved teachers was held on August 28, 1997. The purpose of the meeting was to briefly review and discuss the rationale, goals, and objectives for the Sheboygan Testing the Waters project. Also, the student/teacher orientation field day at Maywood Environmental Center was discussed. Last, expectations for participating schools were determined and agreed upon. August 1997

Locating a suitable instrument for use in the survey of control and treatment groups.

Research was done to determine whether or not it would be necessary to develop a new survey instrument or if one already existed that would be suitable for use in this project. A survey had been put together by the Wisconsin Center for Environmental Education (WCEE) in 1996 that questioned students’ values, behavior, and knowledge as they relate to EE. This instrument was used in this project with some modifications.
The paper and pencil survey was designed to measure student performance relating to the objectives of the Sheboygan Testing the Waters project. Objectives related to student values, behavior, knowledge, and citizen action skills. Items from the 1996 WCEE survey that best measured knowledge, values, and citizen action skills objectives were selected and used on the survey developed for this project.

Identification of treatment and control group of students

Surveying students using the pre-post survey was discussed with participating teachers at the August 28, 1997 meeting. At this time teachers were asked to identify a control group with similar characteristics of the treatment population. Further, they were asked to administer the survey and bring back the answer sheets to the September, 1997 meeting.

August/September 1997

Administration of the pre/post survey to the treatment and control groups and interpretation and comparison of the data.

The pre-survey was administered to both the treatment and control groups in September, 1997. The surveys were proctored by the teachers of the class in which the students were taking the survey.

September 1997

The survey instrument was again administered to both groups of students the second week of May, 1998. Upon completion of the surveys, they were collected and scored. Data were then analyzed to determine the mean of values and behavior data based upon a likert scale of 1 to 5. The knowledge and action skills questions were graded on a percentage correct basis with mean percent scores determined. After calculating the mean scores, means were studied to determine if there were any comparative increases or decreases which would be of educational interest. Further analysis of the data helped in assessing the strengths and weaknesses of the Testing the Waters Project.

May, 1998
Recruit and maintain teachers and community members that may participate in the Testing the Waters Project.

All teachers who had participated in the Testing the Waters Project in the past were contacted by letter in August of 1997. All middle and high schools in Sheboygan County were also contacted and invited to participate in the project by a letter sent to the school’s EE liaison or principal.

On September 18, 1997 a student/teacher orientation was conducted. The orientation consisted of three parts: 1) land use education, 2) introduction and practice of the nine water quality “Q-value tests” and use of benthic macroinvertebrates to assess water quality, and 3) discussion of citizen action skills and potential action projects.

Many community members were contacted by letter and phone to assist and support the project. Community members who assisted at the orientation consisted of the following: Dave Kukuc and Tom Finley-staff members of Maywood Environmental Park; Steve Gularneu, Tom Aartela, and Pam Packer from the Wisconsin Department of Natural Resources; Eric Fehlhaber of the Sheboygan County Land Conservation Department; Kevin Ferminich-Sea Grant Institute at U.W. Manitowoc; and Steve Rowe-Krumdick of Rust Environmental and Infrastructure of Sheboygan.

The project culminated for the school year in a student/community forum, where students presented their water quality data, their analysis of that data, and recommendations for action, or actions taken to maintain or improve the water quality of the watershed area they had been monitoring. Students from each participating school reported findings to students and teachers of the other participating schools and members of the community attending the forum. Pam Packer, Eric Fehlhaber, Steve Rowe-Krumdick, Steve Gularneu and a reporter from the Sheboygan Press were in attendance at the forum as well as the participating teachers and students.
Establishment of clear goals and objectives for the project

A meeting to orient participating teachers was held on August 28, 1997. Existing rationale, goals and objectives of the Testing the Waters Project were discussed and agreed upon. (See Appendix E for a copy of rationale, goals, and objectives of the project.) Also, a schedule for the student/teacher orientation field day at Maywood Environmental Center was set. Last, expectations for participating schools were determined and agreed upon. These expectations included that at least two test dates be conducted at each school. These test dates would be conducted once in the Fall and once in the Spring, using all nine Q-value tests. Testing dates were to be conducted on the second Thursday of the month so that schools could easily compare data.

Locating a suitable instrument for use in the survey of control and treatment groups.

Research was done to find examples of surveys that had already been constructed. The survey that best met the objectives of the project was the “Wisconsin High School Environmental Survey” put together by Phyllis Peri of the Wisconsin Center for Environmental Education, 1996. Due to differences in the Testing the Waters project, modifications were made to the survey instrument. The original survey was designed to survey students on a broad range of environmental issues, whereas the revised survey was used to survey students on environmental issues relating to aquatic environmental issues. (See Appendix A and B for a copy of both the original and revised versions of the survey.)

Deleted from the original version of the survey included a five question introductory section on personal background. Further, the revised survey consisted of only fifteen questions relating to student EE values whereas the original had thirty. The original version of the survey contained sixteen items surveying student EE behaviors, the revised version contained ten of these items. The last revision involved the knowledge and action skills questions. The original consisted of forty-eight of these questions, while the revised consisted of fifteen questions from
the original survey and five questions created specifically for this project.

These newly created questions were specific knowledge and process questions relating to knowledge, process and analysis skills directly relating to the Testing the Waters project. Questions were selected from the original survey on the basis of their relevance to the Testing the Waters project. Thus, primarily more aquatic ecology knowledge questions were included in the survey.

Identification of treatment and control group of students

Testing students using the pre-post test was discussed with teachers at the August 28 meeting. At this time it was determined that administering the survey instrument to all students involved in the project would be difficult due to consistent identification of control groups at all schools involved. Several schools and teachers were involved in the project. Students involved in the program were of different ages and involved in the project for different reasons. Therefore, it was difficult to identify a consistent control group at all schools. Thus an initial treatment group of 19 students and a control group of 15 students, all from Sheboygan South High School, were identified.

The treatment students were active participants in Sheboygan South’s Testing the Waters Project. These students consisted of seven volunteers from the South High Environmental Club and twelve students from South High Advanced Biology classes who were interested in participating in the project. The treatment group consisted of 12 females and 7 males in grades ten through twelve. The control group consisted of randomly selected students; ten from Advanced Chemistry, Physics, and five students enrolled in Sophomore Biology classes at South High. Students from advanced classes were selected to match those from the Advanced Biology class. Students from the Sophomore Biology class were selected to match those who volunteered from the environmental club. The control group consisted of six females and nine males in grades ten through twelve.
Administration of the pre/post survey to the treatment and control groups and interpretation and comparison of the data.

The pre-survey was administered to both the treatment and control groups at South High in early September, 1997. The surveys were proctored by the teachers of the class in which the students taking the survey were in. The survey instrument was again administered to both groups of students the second week of May, 1998.

As can be seen in Table 1, for both pre and post survey, the treatment group scored higher in most categories: values, behavior, action skills and knowledge. The only exceptions were behavior and action skills pre test scores. Behavior pre survey scores for the control group was 2.49 compared to 2.38 for the treatment group. Action skills pre survey scores were 0.76 for the control group and 0.67 for the treatment group.

Tables 2 and 3 show differences in pre survey mean likert scores for all categories; values, behaviors, knowledge and action skills. Differences in pre survey scores were 0.32 for values and 0.11 for behaviors, both based on 1 to 5 Likert scale, and 0.22 for knowledge and 0.09 for action skills, the latter two categories based on a percentage of items correct. From these data it can be seen that the treatment group scored higher initially in two categories: values and knowledge, the control group scored higher in the other two categories: behavior and action skills. Table 4 compares the post survey means comparison of environmental values and behavior. Table 5 makes the same post survey comparison for environmental knowledge and action skills.

Tables 6 compares pre versus post data for values and behavior scores, while Table 7 compares the pre to post knowledge and action skills scores. Table 8 indicates the percentage change from pre to post survey for values, behavior, knowledge, and action skills questions. From these tables, it can be seen that the treatment group improved scores from pre to post for all four categories: values 0.08, behavior 0.11, knowledge 0.25, and action skills 0.11. The control group went down in three of the four categories: values -0.015, behavior -0.04, knowledge 0.22, and action skills -0.33.
Mean scores of all individual questions from the survey, both pre and post, for all four categories can be seen in Appendix I.
Table 1
COMPARISON OF PRE/POST SURVEY MEAN SCORES

<table>
<thead>
<tr>
<th></th>
<th>Treatment</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Values ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre test</td>
<td>4.06</td>
<td>3.74</td>
</tr>
<tr>
<td>post test</td>
<td>4.41</td>
<td>3.72</td>
</tr>
<tr>
<td>**Behaviors **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre test</td>
<td>2.38</td>
<td>2.49</td>
</tr>
<tr>
<td>post test</td>
<td>2.69</td>
<td>2.38</td>
</tr>
<tr>
<td><strong>Knowledge</strong>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre test</td>
<td>0.56</td>
<td>0.34</td>
</tr>
<tr>
<td>post test</td>
<td>0.76</td>
<td>0.43</td>
</tr>
<tr>
<td>**Action Skills ***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre test</td>
<td>0.67</td>
<td>0.76</td>
</tr>
<tr>
<td>post test</td>
<td>0.76</td>
<td>0.51</td>
</tr>
</tbody>
</table>

* On a scale of 1 to 5: 1 = strongly disagree and 5 = strongly agree
** On a scale of 1 to 5: 1 = never and 5 = almost always
*** On a percentage scale, i.e., percentage of items correct
Table 2
PRE VALUES AND BEHAVIOR QUESTIONS MEANS COMPARISON
Table 3
PRE KNOWLEDGE AND ACTION SKILLS QUESTIONS MEANS COMPARISON

![Bar chart showing percentage of items correct for Knowledge and Action Skills]

- Treatment
- Control
Table 4
POST VALUES AND BEHAVIOR QUESTIONS MEAN COMPARISON
Table 5
POST KNOWLEDGE AND ACTION SKILLS QUESTIONS MEANS COMPARISON

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Action Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>Control</td>
</tr>
</tbody>
</table>

Percentage of Items Correct
Table 6
PRE VERSUS POST DATA FOR VALUES AND BEHAVIOR QUESTIONS
Table 7
PRE VERSUS POST DATA FOR
KNOWLEDGE AND ACTION SKILLS QUESTIONS

![Bar chart showing the percentage of items correct for Knowledge and Action Skills Pre and Post for Treatment and Control groups.](chart.png)
Table 8
PRE VERSUS POST PERCENTAGE CHANGE FOR VALUES, BEHAVIOR, KNOWLEDGE, AND ACTION SKILLS MEAN SCORES
Conclusions, Recommendations, and Implications

Recruit and maintain teachers and community members that may participate in the Testing the Waters Project.

Conclusions and Recommendations

It was concluded that cooperation from teachers of all participating schools is essential. With more schools having increasing E-mail capabilities this task should become easier for an individual organizing a similar project in the future.

A Fall orientation for students and teachers is essential if water quality data is going to be compiled and compared between schools. Having a common orientation will ensure that all students involved will have common methodologies, which is essential for accurate data comparison. The orientation should not only include training in water quality testing methodologies, but also focus on land use, action skills, and potential action strategies.

Contacting community members for assistance in the program is very time consuming. It is suggested that data bases be established so that rapid mailings can be generated, and use E-mail communications whenever possible. E-mail provides rapid and personal communication which is important when coordinating a single day program such as an orientation because dates, times, and tasks may change and can be communicated rapidly by E-mail.

A culminating activity such as a student/community forum is highly recommended to end the testing year. This forces the students to review their year of data collection, analyze, compare, and make recommendations for improving the water quality of the watershed based upon their and other schools data. It is recommended that community members be invited to observe student data and/or listen to student presentations. This provides an interchange of ideas for students and adults, as well as providing students with a sense of purpose for conducting the research on the watershed.
Environmental Education Implications

Since Environmental Education is directly tied to the local community, it is critical that involvement in Environmental Education involves a community, not just an isolated class of students. A natural feature which ties communities and regions together are watersheds. Thus using the watershed as a means for teaching students about water quality and conducting water action projects is a logical way to connect students, schools, and communities with respect to water resources.

Establishment of clear goals and objectives for the project

Conclusions and Recommendations

It was concluded that clear goals and objectives for a program such as Testing the Waters are essential as there are many teachers and community support people involved. Everyone involved needs to have a clear understanding of the goals and objectives of the program. Further expectations of participating schools and cooperating community members should be clearly stated to avoid misunderstandings. Last, teachers and community members involved in the program should discuss attainment of goals, objectives, and expectations after the year and make recommendations for improvement.

Environmental Education Implications

Goals and objectives are essential tools of the environmental educator so that progress can be measured. Also, it is important that a program is founded on sound goals if there are any questions or concerns from the community. This is especially true of a student water monitoring program as it may impact certain segments of the community. If members of the
community question the programs goals and objectives, it essential that they be readily available and defendable.

Locating a suitable instrument for use in the survey of control and treatment groups

Conclusions and Recommendations

It was concluded that using an existing environmental education survey is better than creating a new one. The existing survey that was selected had already been tested and statistically analyzed. It was necessary to revise the survey somewhat in order for it to meet the needs of the study.

The survey should be short enough to complete within a class period yet long enough to cover adequately the areas that are pertinent to the project. In this case, questions pertaining to water quality were selected more often than those dealing with terrestrial environmental issues. Further, a concise and simple survey may make teachers and students alike more willing to cooperate. Ease of scoring must also be taken into account as there will likely be many surveys to score.

Environmental Education Implications

Selection of an appropriate environmental education survey instrument is extremely important, this is because results of the survey can be used to assess the strengths and weaknesses of a project. Administering the survey at the beginning and the end of a school year provides the opportunity to measure how much students’ environmental values, behaviors, knowledge, and action skills changed over the course of the project.
Identification of treatment and control groups of students

Conclusions and Recommendations

It was concluded that an ideal control group is very difficult to identify. This is especially true in a project such as this where students from many schools, grade levels, and abilities make up the treatment group. It is best to clearly identify and define a treatment group, even if it is small, so that a suitable control group can be identified. This project used a treatment group of 19 students and a control group of 15 students for this reason.

It is also important to clearly communicate objectives and expectations of the survey to any teacher who may be administering the survey. Validity of results are dependent upon consistent proctoring of the survey.

Environmental Education Implications

The identification of a control group which is comparable to the treatment group is essential to good research. Thus, when assessing environmental education projects, care should be taken to clearly identify a suitable control group. This will lead to sound research providing a basis for environmental education to continue and substantiate its importance in education.

Administration of the pre/post survey to the treatment and control groups and interpretation of the data.

Conclusions and Recommendations

It can be concluded that some educationally significant changes occurred in environmental values, behaviors, knowledge, and action skills of the groups being tested. The
treatment group showed positive changes within all four categories, while the control group showed an increase in knowledge, small decreases in values and behavior, and a large decrease in action skills, see Table 8. From this data it can be seen that the treatment group displayed greater changes in all categories of the survey as compared to the control group.

The knowledge category showed the largest gain for both the treatment and control groups. The treatment group showed an percentage increase of 0.25 where as the control group showed a gain of 0.22, see Table 8. These gains indicate that environmental knowledge was gained over the course of the school year by both groups of students. The control group was made up of Advanced Chemistry and Physics, as well as Sophomore Biology students, and because there are some environmental education objectives and concepts covered in these courses, these students showed a strong increase in the knowledge component of the survey. The treatment group's increase can be explained partially by the factors described for the control group, but the additional increase could be explained by the involvement in the Testing the Waters Project.

The environmental values and behavior categories both showed similar pre to post percentage change patterns between the treatment and control groups. In the values category, the treatment group gained 0.08 while the control group dropped a very small amount of -0.015, see Table 8. The behavior category for both groups showed similar changes: an increase of 0.11 for the treatment group and a decrease of -0.04 for the treatment group, refer to Table 8. Although both the gains for the treatment group and losses for the control group are small, these data indicate that there were positive changes in student environmental values and behavior as a result of involvement in the Testing the Waters Project. Changes in the treatment group may be a result of the nature of the Testing the Waters project; active participation in a real world problem solving activity - monitoring the water quality of the Sheboygan River. Student's active involvement may have lead to positive change in their values and behavior toward the environment.

When examining the pre survey mean likert scores in Table 2, it can be seen that both treatment and control groups score higher in the values category than in the behaviors category.
This is not surprising when considering that changing behavior requires much more work and commitment on the part of the individual student than just changing one's values towards the environment. This difference between student value and behavior scores still remains in the post survey scores, see Table 4. Thus, the Testing the Waters project did positively change treatment students scores for both environmental values and behavior, it did not decrease the difference between the two categories.

The environmental action skills category increased by a percentage of 0.11 in the treatment group and decreased -0.33 in the control group, see Table 8. The large decrease in the control group is troubling because it indicates that these survey questions may not be measuring accurately student action skills. Supporting this idea is that there were only six action skills questions on the survey, see Action Skills Mean % Comparison Table in Appendix I. This number of questions may be too small in number to accurately measure students' environmental action skills.

A different explanation of the action skills data is that the control group students initially had strong environmental action skills, but because these skills were not taught in their regular education courses, the students did not retain these skills from the pre survey to the post survey. If this second explanation is true, it can than be assumed that the treatment group's positive gain of 0.11 is a result of involvement in the Testing the Waters project. One of the objectives of the Testing the Waters project is for students to become involved in an action project involving the Sheboygan River, thus an increase in environmental action skills would indicate that these treatment students retained action skills which were presented during the project.

**Environmental Education Implications**

From the results of the survey it is clear that the control group did not improve in environmental values, behavior, and action skills during the school year. There was an increase in knowledge scores. This implies that regular education courses may be increasing student's
knowledge about environmental issues, but is not addressing the equally important areas of environmental values, behavior, and action skills.

An environmental monitoring project such as the Sheboygan County Testing the Waters Project provides a community based action project which involves students addressing and solving real world environmental issues. The increase in all four categories, environmental values, behaviors, action skills, and knowledge highlights the difference between regular education and environmental monitoring projects: students involved in monitoring not only show an increase in retention of environmental knowledge, but also modest increases in environmental values, behavior, and action skills. These modest increases were not found in the control group of students.
Summary

During the 1997-98 school year, an analysis of pre and post environmental survey data showed that students involved in the Sheboygan South High School Testing the Waters project showed greater gains in environmental values, behavior, knowledge, and action skills than did a similar control group of students from Sheboygan South. The control group showed an increase in environmental knowledge and a decrease in environmental values, behavior, and action skills.

The project participants' strong scores may be attributed to the nature of the project: one in which not only environmental knowledge content is taught, but also the objectives of environmental values, behaviors, and action skills. These objectives are attained by involving students in a community based environmental monitoring project, with the goal that students will eventually take positive environmental action in regards to the Sheboygan River Watershed.

The increase in the control group's environmental knowledge scores can be explained by the environmental education content taught in the regular education classes at South High School. The decrease in environmental values, behavior, and action skills indicates that these objectives and skills are not being retained by methods in the regular education setting at Sheboygan South High School.

It is clear that students participating in environmental monitoring projects possess only slightly more environmental knowledge than similar students not involved in such a project. However, students involved in the project possess a much higher level of environmental values, behaviors and action skills.
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APPENDIX A

Original Version of the Environmental Survey
Instructions for taking the survey:

Today you will be taking a survey that asks questions about what you know, think, and do about the environment and environmental problems. Please answer the questions truthfully and to the best of your ability.

You should have received this survey booklet and an answer sheet for recording your answers. First, using a number 2 pencil, write the first initial of your last name and your entire first name in the spaces provided on the answer sheet and darken the corresponding circles below each letter of your name.

Next, go to the section on the answer sheet marked special codes. Write the number that your teacher will give you in the space marked special codes and darken the appropriate circles under each number.

It is very important to fill in the answer sheet carefully using the number 2 pencil. Fill in only one bubble on the answer sheet for each question asked. When filling in your answer, make sure that you completely darken the circle for your choice on the answer sheet. If you make any changes in your answers, be sure to completely erase your first answer. Do not make any stray marks outside the circles.

There are four sections in the survey. Each section is different, so please read the directions carefully before starting each section. Complete the entire survey and then stop -- you do not need to stop between sections.

If there are any questions about these directions, please ask them now. You may begin the survey.
Section One

Instructions for Section One: Fill in the circle on your answer sheet for the letter of the answer that best indicates your response to each of the following questions.

1. What is your gender?
   a) female
   b) male

2. Compared to other subjects you study, how do you feel about studying environmental topics?
   a) less interested
   b) about the same
   c) more interested

3. Compared with other students your age, how well do you think you understand issues related to the environment?
   a) above average
   b) average
   c) below average

4. What one thing has contributed most to your understanding of the environment and environmental issues? (choose only one answer)
   a) school
   b) books, newspapers, or magazines I have read on my own.
   c) friends or family members (including parents)
   d) field trips, special programs or activities such as clubs, scouting or 4H
   e) television programs

5. What are your educational plans after high school?
   a) no future educational plans at the present time
   b) vocational/technical school
   c) college or university
   d) military
   e) undecided
Section Two

Instructions for Section Two: Please indicate how you feel about each statement below. There are no right or wrong answers. Read each statement carefully. Fill in the circle on your answer sheet for the letter that best indicates the extent to which you agree or disagree with each statement, using the following key:

strongly agree (a)
agree (b)
no opinion (c)
disagree (d)
strongly disagree (e)

I enjoy watching TV programs about nature.
When I am outside, I usually don’t notice the natural things around me like flowers, trees, and clouds.
I’m not interested in reading about nature or the environment.
I like hearing the sound of animals such as birds and insects calling when I’m outside.
I think most of the concern about environmental problems has been exaggerated.
Knowing about environmental problems and issues is important to me.
A community’s pollution regulations should not interfere with industrial growth and development.
I am concerned about the issue of deforestation.
I think that damage to the ozone layer is something that everyone should be concerned about.
More controls should be placed on industry and agriculture to protect the quality of the environment, even if it means that things that I purchase will cost more.
I am not concerned about the fact that the world’s deserts are increasing in size.
There are already enough laws to protect the environment.
I believe that plants and animals exist to be used by humans.

I don't think that recycling is worth all the trouble it takes.

I would oppose any environmental regulations that would restrict my way of life.

More land should be set aside for wildlife habitats.

Environmental restrictions should be lifted so that exploration and production of fossil fuels can be increased.

If a person's car exceeds certain standards for air pollution, he or she should not be allowed to drive it.

The government should provide financial support for research and development related to renewable energy, even if it means that taxes will be higher.

I am concerned about how much waste is produced in this country.

Laws should be passed and enforced that protect the quality of life in the future even if it means that individual freedoms are limited.

I am not concerned about the rate of species extinction in the world.

I am concerned about environmental health hazards such as those caused by air or water pollution.

I want to help solve environmental problems.

There is not much that I can do that will help solve environmental problems.

I believe that I can contribute to the solution of environmental issues by my actions.

It's too hard to change my friends' minds about doing things to help the environment (for example, recycling).

An individual, working on his or her own, can contribute to the solution of environmental problems and issues.

Things that I do don't have much effect on the quality of the environment.

I feel that it is my responsibility to help solve environmental problems.
Section Three

Instructions for Section Three: For the following group of statements, please indicate how frequently you do each of the actions mentioned. Be honest, there are no right or wrong answers. Fill in the circle on your answer sheet for the letter that is closest to your answer, using the following key:

- almost always (a)
- often (b)
- sometimes (c)
- almost never (d)
- never (e)

I turn off lights and appliances when they're not being used in order to conserve electricity.

I avoid purchasing products that are over-packaged.

I talk to people that I notice doing something that harms the environment in an effort to persuade that person to stop that activity. (For example, try to talk a friend into recycling pop cans instead of throwing them in the trash.)

I walk, take public transportation, or ride a bike instead of using a car in order to help protect the environment.

I make an effort to reduce the amount of goods I consume.

I set a positive environmental example for my friends to follow.

I support candidates for school offices who are concerned about environmental problems and issues in our school.

If I see an aluminum can on the ground when I'm out walking, I pick it up and take it with me.

I recycle paper, glass, and/or metal waste products at home or at school.

I avoid purchasing products that have a negative impact on the environment.

I talk to my family and friends about what they can do to help solve environmental problems.

I write or call politicians to express my views about environmental issues.
I make a point of reading newspaper and magazine articles about the environment.

I purchase one product over another product because it is packaged in reusable, returnable, or recyclable containers or packages.

I send letters to the newspaper about environmental problems or issues.

I have reported environmental problems or violations that I have noticed to the proper authorities.

Section Four

Instructions for Section Four: For each of the following questions, choose the best answer. Fill in the circle for the letter of the answer on your answer sheet.

2. A food web consists of

   a) the animals that eat other animals in a community.
   b) all the herbivores and carnivores in an ecosystem.
   c) many interconnected food chains.
   d) all the consumers in an ecosystem.

3. When two or more species attempt to use the same limited resource in an ecosystem, their interaction is called

   a) mutualism.
   b) competition.
   c) predation.
   d) commensalism.

4. Having sharp thorns can help a plant by keeping animals from eating it. This is an example of

   a) mutualism.
   b) adaptation.
   c) competition.
   d) commensalism.
5. All of the individual organisms that live on the ground in a particular forest share the same

   a) niche.
   b) habitat.
   c) life-style.
   d) food source.

6. The reason dead leaves and twigs don't build up in a forest from year to year is because

   a) non-living elements such as wind and rain remove them.
   b) decomposers break them down into soil.
   c) animals eat them or use them to build nests.
   d) none of the above.

Wolves often eat deer. Does this interaction have any beneficial effects on the deer population as a whole?

   a) Yes, the wolves help keep the deer population size controlled.
   b) No. The deer population is usually only harmed.
   c) Yes, the wolves help keep the deer population strong since the fastest, most alert deer survive.
   d) both (a) and (c)

The energy currently present

   a) is all the energy we will ever have.
   b) can change form but is never destroyed.
   c) can only be used once.
   d) is mostly in the form of fossil fuel energy.

Based upon major ecological principles, we should conclude that

   a) humans are a climax species that will last indefinitely.
   b) the human species will soon become extinct; nothing we can do will prevent this.
   c) the human species will last as long as there is a balanced ecosystem that will support human life.
   d) there is no way of predicting what will happen to the human species; ecological principles do not apply to humans.
60. The process of photosynthesis in green plants
   a) uses sunlight to burn energy in plants.
   b) changes light energy into chemical energy.
   c) changes chlorophyll into sugar.
   d) is a process used to burn sugar stored in plants so the plants can grow.

61. Which of the following terms is used to describe all of the natural living and nonliving interacting features of a given area?
   a) habitat
   b) community
   c) biodiversity
   d) ecosystem

62. Humans grow crops for food. Many species of these plants need certain species of insects (such as bees) to pollinate them. The pollinating insects often rely on the nectar they obtain from the plants for food. This is a good example of
   a) how organisms, including humans, are interdependent.
   b) commensalism between humans and other species.
   c) how humans manipulate their environment.
   d) a food web that includes humans.

63. A particular aquatic ecosystem is contaminated by a chemical which tends to remain stored in body fat. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem?
   a) plant life
   b) minnows
   c) fish that eat insects and plants
   d) fish-eating birds

64. Which of the following phrases refers to the potential ability of a system to support population growth without harming the environment?
   a) carrying capacity
   b) species loading
   c) non-sustainable growth
   d) all of the above
In a small lake, a food chain was as follows:

sun → green algae → small crustaceans → fish

After many months of heavy snow covering the ice, most of the small crustaceans died. What is the best explanation for this?

a) The algae population was cut off from its source of energy.
b) It was too cold for the crustaceans to survive.
c) The fish ate most of the crustaceans.
d) A disease killed most of the algae.

If carbon dioxide (CO₂) disappeared from the atmosphere, which of the following would be affected first?

a) plants
b) animals that eat plants
c) animals that eat other animals
d) decomposers

Each of the following food chains starts with the same amount of green plants. Assuming that the green plants are digestible by humans, which of the food chains would supply the most energy to humans?

a) green plants to humans
b) green plants to cattle to humans
c) green plants to insects to fish to humans
d) green plants to insects to small fish to larger fish to humans

Some insecticides that were once effective in killing insects no longer work very well. This is because

a) new insect species develop every day.
b) the wrong kind of insecticides were used.
c) insects with natural resistance survived and multiplied.
d) the insects produced many more offspring than the insecticide could kill.
69. Which of the food webs below would be affected the most if all of the mice were removed? (Note: the arrows point to the consumer of the organism in the food web)

Food Web (A)
- owls → snakes → voles → mice → plants
- owls → rabbits

Food Web (B)
- owls → snakes → mice → rabbits
- owls → rabbits

a) food web (A)
b) food web (B)
c) Neither would be affected.
d) They would both be affected to the same degree.

70. Which of the following contributes to air pollution at the surface of the earth, and acts as a shield against ultraviolet rays in the upper atmosphere?

a) nitrous oxide
b) methane
c) ozone
d) sulfur dioxide

71. The main source(s) of emissions that have been identified as contributing to acid deposition (acid rain) in the United States are

a) volcanoes and forest fires.
b) petroleum refineries.
c) automobiles and coal burning power plants.
d) aerosol sprays and refrigerant leakage.

72. Which of the following is not true of the world’s human population?

a) It is expected to double within your lifetime.
b) It is declining in developed areas such as the United States and Canada.
c) Its increase has led to the extinction of many plant and animal species.
d) The greatest rate of population growth is occurring in developing areas such as South America and Africa.
73. The future of food production as it is currently practiced in this country is in question because
   a) soil is being depleted by erosion.
   b) the use of synthetic chemical additives has become an issue.
   c) agricultural land is being lost to development.
   d) all of the above.

74. Which of the following would be most likely to cause groundwater pollution?
   a) organic farming practices
   b) municipal composting of yard wastes
   c) adding too much fertilizer to fields
   d) wastewater treatment plants

75. The rate of species' extinction is higher now than at any time since the period of the dinosaurs' extinction. The main cause of this rapid decline in biodiversity is
   a) habitat alteration by humans.
   b) the illegal poaching or collecting of animals and plants.
   c) changes in the Earth's atmosphere due to human activities.
   d) hunting by humans for food or sport.

76. Which of the following do scientists feel is the least important contributor to the greenhouse effect?
   a) destruction of the earth's rainforests
   b) burning of fossil fuels, such as gasoline and oil
   c) increased use of hydroelectric power
   d) production of methane gas by cattle and rice paddies

77. Most municipal solid waste in the United States is presently disposed of by what method?
   a) burning it in closed incinerators
   b) recycling
   c) shipping it out to sea and dumping it
   d) burying it in landfills
78. Which of the following is NOT a major water pollutant?
   a) bacteria
   b) pesticides
   c) heat
   d) All of the above are major water pollutants.

79. One suggested advantage of using nuclear power plants for energy production is that
   a) nuclear power plants are not expensive to build.
   b) the waste products are fairly easy to store.
   c) there is less air pollution.
   d) they are totally safe.

80. Which of the following results in the most serious waste or loss of our usable water?
   a) contamination by bacteria
   b) uncontrolled drainage
   c) careless usage
   d) improper storage

81. Which of the following would be most likely to result in soil erosion?
   a) an increase in nutrients added to the soil
   b) the removal of vegetation
   c) contour plowing of hillsides
   d) aeration of the soil by bacteria

82. Which of the following is considered to be a non-renewable energy source?
   a) oil
   b) wood
   c) biomass
   d) none of the above
83. Which of the following is a naturally occurring, invisible gas which can seep out of the ground into people's homes and cause serious health problems?
   a) ethane
   b) krypton
   c) radon
   d) chlorofluorocarbon

84. A major nuclear accident occurred in 1986 at the ______ nuclear power plant.
   a) Belgrade
   b) Nagasaki
   c) Chernobyl
   d) Three Mile Island

85. Which of the following offers the most potential for reducing our immediate energy problems?
   a) geothermal power
   b) energy conservation
   c) biomass conversion
   d) tidal power

86. Having your household water tested is important if
   a) you live in an old house.
   b) your water comes from a well.
   c) you live in an agricultural area.
   d) all of the above.

87. Which of the following is most likely to help endangered species?
   a) Outlaw the sale or possession of endangered species or products made from them (skins, furs, ivory, etc.).
   b) Create breeding programs in zoos for endangered animals.
   c) Use farming methods which do not damage habitat.
   d) Maintain large protected natural areas where they live.
88. In the long term, which of the following would be the best way to lessen the problem of solid waste?

a) Incinerate waste materials.
b) Reduce the amount of materials being consumed.
c) Reuse materials for other purposes rather than throwing them out.
d) Recycle materials that can be used again.

89. Which of the following would be the most effective method to influence a large number of people to take action about an environmental problem?

a) Advertise on the radio.
b) Write letters to the newspaper.
c) Go door to door and talk to people.
d) Use a combination of the above.

90. If your student environmental club was concerned about an environmental issue, which of the following would be the best thing to do first?

a) Write and circulate a petition about the issue.
b) Talk to other people about what they could do to help resolve the issue.
c) Write to elected officials about your concern.
d) Research the issue.

This is the end of the survey. Thank you for your participation!
APPENDIX B

Revised Version of the Environmental Survey
Instructions for Part One: Please indicate how you feel about each statement below. There are no right or wrong answers. Read each statement carefully. Fill in the circle on your answer sheet for the letter that best indicates the extent to which you agree or disagree with each statement, using the following key:

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>No opinion</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
</tr>
</tbody>
</table>

1. When I am outside, I usually don't notice the natural things around me like flowers, trees, and clouds.

2. I'm not interested in reading about nature or the environment.

3. I think most of the concern about environmental problems has been exaggerated.

4. A community's pollution regulations should not interfere with industrial growth and development.

5. More controls should be placed on industry and agriculture to protect the quality of the environment, even if it means the things that I purchase will cost more.

6. I would oppose any environmental regulations that would restrict my way of life.

7. I am concerned about how much waste is produced in this country.

8. Laws should be passed and enforced that protect the quality of life in the future even if it means that individual freedoms are limited.
9. I am concerned about environmental health hazards such as those caused by air or water pollution.

10. Knowing about environmental problems and issues is important to me.

11. I want to help solve environmental problems.

12. There is not much that I can do that will help solve environmental problems.

13. I believe that I can contribute to the solution of environmental issues by my actions.

14. An individual, working on his or her own, can contribute to the solution of environmental problems and issues.

15. Things that I do have little effect on the quality of the environment.

**Part Two**

**Instructions for Part Two:** For the following group of statements, please indicate how frequently you do each of the actions mentioned. Be honest, as there are no right or wrong answers. Fill in the circle on your answer sheet for the letter that is closest to your answer, using the following key:

<table>
<thead>
<tr>
<th>Almost Always</th>
<th>Often</th>
<th>Sometimes</th>
<th>Almost Never</th>
<th>Never</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>(b)</td>
<td>(c)</td>
<td>(d)</td>
<td>(e)</td>
</tr>
</tbody>
</table>

16. I walk, take public transportation, or ride a bike instead of using a car in order to help protect the environment.

17. I make an effort to reduce the amount of goods I consume.

18. I set a positive environmental example for my friends to follow.
19. I avoid purchasing products that have a negative impact on the environment.

20. I talk to my family and friends about what they can do to help solve environmental problems.

21. I write or call politicians to express my views about environmental issues.

22. I make a point of reading newspaper and magazine articles about the environment.

23. I purchase one product over another product because it is packaged in reusable, returnable or recyclable containers or packages.

24. I send letters to the newspaper about environmental problems or issues.

25. I have reported environmental problems or violations that I have noticed to the proper authorities.

**Part Three**

**Instructions for Part Three:** For each of the following questions, choose the **best** answer. Fill in the circle for the letter of the answer on your answer sheet.

26. Which of the following words is used to describe all of the natural living and nonliving interacting features of a given area?
   a) habitat
   b) community
   c) biodiversity
   d) ecosystem
27. A particular aquatic ecosystem is contaminated by a chemical which tends to remain stored in body fat. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem?
   a. plant life
   b. minnows
   c. fish that eat insects and plants
   d. fish-eating birds

28. Which of the following is NOT a major water pollutant?
   a. bacteria
   b. pesticides
   c. heat
   d. All of the above are major water pollutants.

29. Which of the following would be most likely to result in soil erosion?
   a. an increase in nutrients added to the soil
   b. the removal of vegetation
   c. contour plowing of hillsides
   d. aeration of the soil by bacteria

30. Which of the following would be the most effective method to influence a large number of people to take action about an environmental problem?
   a. Advertise on the radio.
   b. Write letters to the newspaper.
   c. Go door to door and talk to people.
   d. Use a combination of the above.

31. If your student environmental club was concerned about an environmental issue, which of the following would be the best thing to do first?
   a. Write and circulate a petition about the issue.
   b. Talk to other people about what they could do to help resolve the issue.
   c. Write to elected officials about your concern.
   d. Research the issue.
32. The water cycle of the Earth is also referred to as the:
   a. hydrospheric cycle.
   b. aqualogic cycle.
   c. hydrogen cycle.
   d. hydrologic cycle.

33. Runoff of fertilizer or sewage discharged into a lake could lead to fish kills because
   a. the fertilizer or sewage poisons the fish.
   b. the nutrients make algae grow and algae poisons most fish when they eat it.
   c. decomposers feeding on dead algae use the oxygen.
   d. None of the above. This situation will not lead to fish kills.

34. Soil erosion is a serious problem because:
   a. it increases turbidity in waterways.
   b. the soil cannot be replaced.
   c. eroded soil causes groundwater pollution.
   d. trees can be uprooted when the soil is washed away.

35. Which of the following would be an effective action that people could take to help reduce soil erosion?
   a. Read and do research about the problem.
   b. Increase the use of fertilizers on farms.
   c. Let the grass in their lawns grow longer before mowing it.
   d. Write to elected officials about the problem so that better legislation will be passed.

36. What is given off by animals and used by plants to make their own food?
   a. hydrogen
   b. oxygen
   c. nitrogen
   d. carbon dioxide
37. Runoff of pesticides and fertilizers into rivers and lakes causes serious problems to natural ecosystems. Which of the following would be the best way to reduce this problem?
   a. Ban the use of chemicals in agriculture and gardening.
   b. Educate people about how to use these products.
   c. Improve farming practices.
   d. Make more powerful pesticides and fertilizers so that smaller amounts can be used.

38. Runoff of polluted water from streets, highways and parking lots into city water systems causes serious water quality problems. Which of the following would be the best way for you to help reduce this problem?
   a. Take public transportation, walk, or ride your bike to school.
   b. Pour used motor oil into the ground rather than into a street drainage gutter.
   c. Use unleaded gasoline in your car.
   d. Help keep the driveways and sidewalks clean around your neighborhood.

39. Which of the following best describes the relationship between the number of different kinds of organisms in an ecosystem and ecosystem’s stability?
   a. There is no relationship.
   b. The larger the number of species of organisms, the greater the stability.
   c. The smaller the number of species of organisms, the greater the stability.
   d. Too small or too large a number of species of organisms will lower the stability.

40. Where would be the best place to gather current research information about a particular environmental problem?
   a. encyclopedias
   b. textbooks
   c. TV news shows
   d. journals or magazines
41. When found in aquatic ecosystems, the nitrogen and phosphorus compounds in untreated sewage:
   a. are produced by bacterial action.
   b. stimulate the growth of plants.
   c. suffocate organisms in the water.
   d. use most of the available oxygen.

42. Organisms such as stoneflies and caddisflies that require large amounts of oxygen would be found in what section of a river?
   a. backwaters
   b. riffles
   c. runs
   d. pools

43. Use the figure below to determine the % oxygen saturation of a water sample that has a dissolved oxygen level of 11.5 parts per million and a temperature of 8°C.
   a. 
   b. 
   c. 
   d. 

44. Of the following water quality tests which would be used to best indicate that there is a source of soil runoff nearby in the stream?
   a. dissolved oxygen
   b. turbidity
   c. temperature
   d. nitrates
45. Of the following water quality tests which would be used to best indicate that there is a source of raw sewage runoff nearby in the stream?
   a. fecal coliform
   b. temperature
   c. dissolved oxygen
   d. total solids
APPENDIX C

List of Schools and Teachers Involved in the Testing the Waters Project
List of Schools and Teachers involved in the Testing the Waters Project

Ms. Jane Arnott
Horace Mann Middle School
2820 Union Avenue
Sheboygan, WI 53081

Mr. Brian Henriksen
Sheboygan South High School
3128 South 12th Street
Sheboygan, WI 53081

Ms. Sue Busche
Sheboygan South High School
3128 South 12th Street
Sheboygan, WI 53081

Ms. Jenny Bidinger
Plymouth High School
125 Highland Avenue
Plymouth WI, 53073

Mr. Jay Grosshuesch
Plymouth High School
125 Highland Avenue
Plymouth WI, 53073

Ms. Tina Henriksen
Plymouth High School
125 Highland Avenue
Plymouth WI, 53073

Mr. Brian Fortney
Kohler High School
230 School Street
Kohler, WI 53044

Ms. Jesse Good
Kohler High School
230 School Street
Kohler, WI 53044

Ms. Lori Walker
Sheboygan Falls Middle School
101 School Street
Sheboygan Falls, WI 53085
APPENDIX D

List of Support Professionals Involved in the Testing the Waters Project
List of Support Professionals Involved in the Testing the Waters Project

Mr. Dave Kuckuk
Maywood Environmental Park
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Sheboygan, WI 53085

Mr. Tom Finley
Maywood Environmental Park
3615 Mueller Road
Sheboygan, WI 53085

Mr. Steve Gularneu
Wisconsin DNR
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Milwaukee, WI 53212

Mr. Eric Fehlhaber
Sheboygan County Land Conservation Department
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Sheboygan Falls, WI 53085

Ms. Pam Packer
WAV Coordinator, WT/2
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Madison, WI 53707

Mr. Kevin Ferminich
Wisconsin Sea Grant Institute
705 Viebahn Street
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Mr. Steve Rowe-Klundick
RUST Environmental & Infrastructure
4738 North 40th Street
Sheboygan, WI 53083
APPENDIX E

Map of Sheboygan River Watershed
The Sheboygan River Basin

Legend
- WWTP
* Sample Site
River Basin Boundary
- Stream
- Highway
Open Water
- Wetland
Municipal Area

Wastewater Treatment Plants
1 Belgium WWTP
2 Onion River Sewage Commission WWTP (formerly Hingham WWTP)
3 Gibbsville WWTP
4 Waldo WWTP
5 Sheboygan County Health Center WWTP
6 Mt. Calvary WWTP
7 St. Cloud WWTP
8 Kiel WWTP
9 Plymouth WWTP
10 Johnsonville Foods

Wisconsin Department of Natural Resources
BIM-GEO Services Section
July 1993

Scale 1:320,000
APPENDIX F

Rationale, Goals, and Objectives
of the Testing the Waters Project
III. Statement of Need: The Sheboygan River has been identified as one of the 43 "hot spots" for Great Lakes pollution. At the present time, there is a major-effort-underway to clean up PCBs in the river bed. A variety of local groups have already been working with government and industry to clean up the river. The Department of Natural Resources is working with the groups to develop a Remedial Action Plan for the Sheboygan River Watershed. Our consortium will work with our Environmental Scientist-in-Residence to jointly develop and execute a comprehensive program for the purpose of educating teachers and students about local surface water, ground water, non-point source pollution and pollution abatement issues in the Sheboygan River Watershed. With the assistance of our Environmental Scientist-in-Residence, teachers and students will work with local water quality groups to increase general public awareness and affect policies in local government and industry.

There has been no organized effort to meet this need in this watershed in prior years. This project will involve three major efforts: Staff development, curriculum and the preparation of citizens to become active participants in the resolution of local environmental issues.

IV. Project Goals and Objectives: Goal 1.0 To provide training for teachers and students so the Sheboygan River project can be implemented.

Objective 1.1: Teachers and student mentors will receive training on 1) river ecology; 2) pollution issues on the Sheboygan River; 3) intervention strategies that potential could improve water quality in the watershed.

Objective 1.2: Students will receive training in using scientific equipment properly, learn to compare and contrast water quality parameters from different points within the watershed over time, and learn about careers in environmental education from working with experts.

Goal 2.0 To establish a network of middle and high school data collecting teams in the Sheboygan River Watershed.

Objective 2.1: Students from each team will learn how to collect the data.

Objective 2.2: Students will learn how to work with other groups on solving our environmental problems in the watershed.

Goal 3.0 To develop and distribute curriculum materials.

Objective 3.1: A teacher guide will be developed and distributed that will include all facets of this program.
APPENDIX G

Fall Orientation Schedule
September 18th Student and Teacher Orientation to Testing theaters - Sheboygan County

8:45-9:10  Program Introduction and Test  
Brian Henriksen

Land Use of Sheboygan River Watershed

9:10-9:45  Biodiversity of Pigeon River slide program  
Vicki Manuge

9:45-10:15  Land use survey form  
Tom Aartela, Steve Galarneau, DNR

Sheboygan River Watershed Update

Q-Value test practice

10:15-1:50  Five stations will be set up which groups of students along with their students will rotate. Five stations will be:

1. D.O./B.O.D.  
Tom Finley

2. Fecal Coliform  
Kevin Ferminich

3. Temperature, Turbidity, Total Solids  
Steve Rowe-Krumdick

4. Total Phosphate and Nitrate  
Pam Packer

5. Macroinvertebrates and pH  
Dave Kuckkuck

Lunch Break in between approximately at noon. Sub sandwiches will be provided, soda available at Maywood.

Action Projects

1:50-2:20  Discuss possible action projects involving water and water quality  
Caroline Johnson

Wrap-up

2:20-2:30  Expectations for school testing teams  
Brian Henriksen
APPENDIX H

Spring Forum Schedule
Testing the Waters - Sheboygan River
Spring Forum Schedule
Tuesday, May 5, 1998

9:00 - 9:15 Time to view boards and introduction.

9:15 - 9:30 Presentations of Independent Study students on their research.

9:30 - 10:30 Presentation by schools. Presentation should focus on the environmental impacts on the watershed based on data trends for your sites and land uses around your sites. Presentations should be from 5-10 minutes with time for questions from other students and adults that we will hopefully have in the audience. We decided an interesting order would be to go from upstream to down with the flow of the river. Thus the order is: Plymouth, Sheboygan Falls, Kohler, Horace Mann, South.

10:30 - 11:15 Development of Action Plans in small groups

11:15 - 11:30 Conclusion, whole group discussion.

11:30 - 1:00 Travel to Maywood. Lunch on your own at Maywood.

1:00 - 2:15 Habitat hike of Pigeon River corridor led by Maywood staff.
APPENDIX I

Means Comparison for Values, Behavior, Knowledge, and Action Skills Categories
KNOWLEDGE MEAN % COMPARISON

percentage of students with correct responses

question #

78
ACTION SKILLS MEAN % COMPARISON

percentage of students with correct responses

question #