ASSESSING EFFECTS OF AN ENVIRONMENTAL EDUCATION FIELD SCIENCE PROGRAM FOSTERING RESPONSIBILITY AT AN URBAN MIDDLE SCHOOL

THESIS

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements For the Degree of

MASTER OF SCIENCE

by

Blake Sills, B.S.S.S.
Denton, Texas
May, 1999
Blake Sills, Assessing effects of an environmental education field science program fostering responsibility at an urban middle school. Master of Science, May, 1999, ninety-four pp., six tables, seven illustrations, references: twenty-two titles.

The study investigated the ability of an extracurricular program to influence environmental responsibility of sixth and seventh graders. The Children’s Environmental Attitude and Knowledge Survey (CHEAKS) was evaluated for appropriateness in assessing the worth of this particular environmental education strategy emphasizing water-quality fieldwork and technology. CHEAKS is designed with psychometric reliability and validity that may be used in comparing disparate programs.

Wilcoxon two sample tests were used to analyze data gathered from two student groups; one participated in an “Enviro-Mentals Club”; the other received no treatment. Analysis showed no significant change in environmental attitudes between groups, but did show significance (p <= 0.05) in environmental knowledge growth. Therefore, the investigated program had marginal success in influencing environmental responsibility.
ASSESSING EFFECTS OF AN ENVIRONMENTAL EDUCATION FIELD SCIENCE PROGRAM FOSTERING RESPONSIBILITY AT AN URBAN MIDDLE SCHOOL

THESIS

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements For the Degree of

MASTER OF SCIENCE

by

Blake Sills, B.S.S.S.
Denton, Texas
May, 1999
ACKNOWLEDGEMENTS

I'd like to acknowledge and thank my wife, Lydia Sills for her long term support of all of my efforts with this project and also my cosponsor, Karen Cagle for her assistance in working with the great kids at William James Middle School.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>vii</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF FIGURES</td>
<td>viii</td>
</tr>
</tbody>
</table>

## CHAPTER I

**INTRODUCTION**
- INTRODUCTION ................................................................. 1
- BACKGROUND ................................................................. 2
- OBJECTIVES OF THE STUDY .................................................. 4
- DESCRIPTION OF THE STUDY .................................................. 7
- HYPOTHESES ................................................................. 7
- ORGANIZATION OF THE THESIS .............................................. 8

## CHAPTER II

**LITERATURE REVIEW**
- ENVIRONMENTAL EDUCATION HISTORY ...................................... 11
- CURRENT SOCIOLOGICAL AND PSYCHOLOGICAL THEORIES ................. 11
- RECENT APPROACHES TO ENVIRONMENTAL EDUCATION ..................... 16
- EVALUATION INSTRUMENT DEVELOPMENT ................................... 16
- OVERVIEW OF PEDAGOGICAL THEORIES ................................... 19
- METHODS USED IN THE WILLIAM JAMES MIDDLE SCHOOL (WJMS) PROGRAM ........................................ 23

## CHAPTER III

**METHODS AND PROCEDURES** .............................................. 27
- SELECTION OF SUBJECTS .................................................... 27
- EDUCATIONAL STRATEGIES .................................................. 31
- FIELD WORK ........................................................................ 33
- LAB WORK ........................................................................... 40
- COMPUTER/INTERNET ACTIVITIES ........................................... 42
- FIELD TRIPS ......................................................................... 43
- ADMINISTRATION OF THE INSTRUMENT .................................... 44
- TREATMENT OF DATA ........................................................ 46
- USE OF THE ENTIRE INSTRUMENT .......................................... 47
- USE OF A MODIFIED SURVEY ................................................ 48
CHAPTER IV
RESULTS DISCUSSION ........................................................................ 51
GROUP STRUCTURE ........................................................................... 51
PROGRAM DESIGN ............................................................................... 52
STATISTICAL ANALYSES AND FINDINGS ........................................ 53
TESTING OF HYPOTHESES ............................................................... 63
CHAPTER V
SUMMARY ......................................................................................... 66
JUSTIFICATION FOR THE STUDY .................................................... 66
OBJECTIVES OF THE STUDY ............................................................. 67
FINDINGS OF THE STUDY ................................................................. 68
RECOMMENDATIONS FOR FUTURE STUDY ..................................... 69
APPENDICES ..................................................................................... 71
APPENDIX A ................................................................................... 72
EVALUATION INSTRUMENT ............................................................... 72
APPENDIX B ................................................................................... 78
EVALUATION INSTRUMENT WITH ANSWERS .................................. 78
APPENDIX C ................................................................................... 84
PROGRAM INFORMATIONAL FLIER .................................................. 84
APPENDIX D ................................................................................... 86
PUBLIC ADDRESS ANNOUNCEMENT .............................................. 86
APPENDIX E ................................................................................... 88
MEMBERSHIP APPLICATION ............................................................ 88
APPENDIX F ................................................................................... 90
SUBSET OF EVALUATION INSTRUMENT ........................................ 90
BIBLIOGRAPHY ............................................................................... 92
LIST OF TABLES

TABLE 1 DESCRIPTION OF STUDENTS PARTICIPATING IN THE STUDY ........................................ 31
TABLE 2 OVERVIEW OF DATA COLLECTION AND TREATMENT PERIODS ................................. 46
TABLE 3 AVERAGE SCORES FOR BOTH GROUPS ON INITIAL AND FINAL SURVEYS ................. 59
TABLE 4 COMPARISON BETWEEN TOTAL CHEAKS SCORES AND WATER QUALITY SUBSET OF CHEAKS SCORES .................................................. 61
TABLE 5 COMPARISON OF LEEMING'S CHEAKS VALIDATION STUDY POPULATION WITH WJMS STUDY POPULATION .............................................. 62
TABLE 6 WILCOXON TWO-SAMPLE TEST TABLE COMPARISON BETWEEN THE EXPERIMENTAL AND CONTROL GROUP RESULTS ........................................ 65
<table>
<thead>
<tr>
<th>FIGURE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIGURE 1</td>
<td>36</td>
</tr>
<tr>
<td>STUDENTS MEASURING TURBIDITY AT CREEK SAMPLING SITE</td>
<td>36</td>
</tr>
<tr>
<td>FIGURE 2</td>
<td>38</td>
</tr>
<tr>
<td>STUDENTS SAMPLING ON YEAR-END LAKE WORTH TRIP</td>
<td>38</td>
</tr>
<tr>
<td>FIGURE 3</td>
<td>39</td>
</tr>
<tr>
<td>&quot;ENVIRO-MENTALS&quot; LABELING STORM DRAINS</td>
<td>39</td>
</tr>
<tr>
<td>FIGURE 4</td>
<td>41</td>
</tr>
<tr>
<td>&quot;ENVIRO-MENTALS&quot; STUDENTS PREPARING SERIAL DILUTIONS</td>
<td>41</td>
</tr>
<tr>
<td>FIGURE 5</td>
<td>42</td>
</tr>
<tr>
<td>&quot;ENVIRO-MENTALS&quot; AUTHORTING WEB SITE</td>
<td>42</td>
</tr>
<tr>
<td>FIGURE 6</td>
<td>55</td>
</tr>
<tr>
<td>SURVEY RESULTS FOR CONTROL GROUP</td>
<td>55</td>
</tr>
<tr>
<td>FIGURE 7</td>
<td>56</td>
</tr>
<tr>
<td>SURVEY RESULTS FOR EXPERIMENTAL GROUP</td>
<td>56</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

Introduction

Students in the Fort Worth Independent School District have limited exposure to any environmental science study during their K-12 education. Except as a choice in an elective science course in high school, students encounter few opportunities to explore the subject within the district’s required science curriculum. Even though the theme of ecology is mentioned in most Biology and Life Science textbooks used throughout the city, the topic is invariably left out of the material presented by science teachers each year. Instead, more traditional items such as cell biology, taxonomy, and genetics take up the majority of the allotted time for coverage of the class’ curriculum. Ironically, the topic of environmental science is one that sparks a high degree of interest in most students and is anticipated from the beginning of the school year by many. Yet, unless an individual teacher has a particular interest or expertise in the field of environmental science, it is often not even mentioned due to the ever-increasing demands of an already packed science curriculum.

As the pursuit of knowledge increases society’s understanding of the way the world of science works, the science textbooks and ancillary materials for presentation in the science classroom increase in size and complexity, yet the amount of time available in
the school year to present the material does not. Invariably the topic of ecology or environmental science is squeezed out of the mix of items covered since it is usually the last unit listed in most textbooks' tables of contents. The subject seems to have a low priority in the minds of most school policy makers.

Many times teachers are compelled to cover other material that has been prioritized higher by those in authority since it is prerequisite to later courses in most students' academic careers. Unfortunately, the important ideas presented in environmental science units usually are not part of state mandated testing nor are they required knowledge for other compulsory courses. If they were, undoubtedly they would receive greater emphasis.

However, these same ideas that are often times missed in a student's education have a more profound affect on his or her understanding of the global community to which all belong than do many of the so called "important topics" that are instead covered repeatedly in standard science courses.

This unfortunate situation is true for most students in other cities in the United States as well. The FWISD's science curriculum is very representative of the mainstream curricular requirements found nationwide. The emphasis in science classes is usually focused away from environmental science topics regardless of their importance to students.

Background

The Texas Natural Resource Conservation Commission (TNRCC) has developed a program to facilitate the grass roots effort of water quality protection among Texas
streams, rivers, and lakes. They call it the “Texas Watch” program. Its goal is to involve Texas citizens in the effort of regular monitoring of individual bodies of water in the state over long periods. It is believed that citizens’ participation and monitoring efforts will enhance their feelings of protection and stewardship of the local natural environment. In turn, the citizens will increase their pro-environmental behavior and attitudes, which will eventually have a beneficial affect on the overall ecosystem that they impact and are a part of. Various citizen groups participate in the Texas Watch program including school groups.

Additionally, TNRCC is able to compile data on hundreds of bodies of water statewide that would otherwise be undocumented. Commission officials are also able to investigate any anomalous readings that are collected by citizens if the need arises.

When cooperating teachers and their students use this type of program (one that involves data collection and analysis in an outdoor setting) to enhance the school’s science curriculum, multiple goals can be accomplished.

- Students that have the chance to engage in activities related to the outdoors can experience types of learning previously unavailable to them in a traditional school science classroom. The dynamics of natural systems as they actually exist can be experienced first hand rather than simulated in an indoor classroom lab facility.
- The skills and procedures developed through this program reflect valuable techniques that are of importance in many areas of data collection, i.e., following observed trends to reach conclusions.
• Exposure to a natural setting may be a novel experience for many urban students. Repeated, periodic data collection allows them the opportunity to experience the outdoors (at least in a small way) more personally than they may have had the opportunity to before.

• The material being presented takes on more immediacy and significance since the student can readily understand the source of the information he or she is learning.

• The active participation involved in acquiring information about the study site allows for an entirely different way for mental processing to occur about water quality and stream ecology as compared to the traditional method of information digestion.

TNRCC encourages teachers and schools to get involved with the Texas Watch program in order to accomplish the aforementioned goals.

Objectives of the Study

There is a great need for environmentally responsible citizens in today’s shrinking natural world. As society grows and demands more and more natural resources, nature will continue to be adversely impacted, sometimes beyond reclamation, unless there are those who intervene. If nature is to be ultimately protected from man’s destructive influences, these environmentally responsible citizens will be the ones who intervene, the ones who will be “speaking for the trees”.
Those among us who value the natural world believe that society must improve its attitudes about natural protection if nature is to have a chance to at least maintain its current state. They understand that decisions and practices about resource use and management are fundamental in preserving the natural value the world still has.

For nature to have a chance at survival, the decision makers, the individuals who ultimately hold the choice in their hands, must be people that have an environmental ethic, that see value in nature. The people who are in these decision-making roles have reached their current positions, as have all of us, with a set of beliefs based on a lifetime's experiences and feelings about the world around them.

Because an individual's attitudes and feelings about the environment and nature are derived from a complex set of influences (Hutchison, 1998), the chore of trying to impact the way a person behaves towards nature can be challenging. Many believe that childhood exposure in this area can positively affect attitudes that individuals will retain as adults. Influences encountered as children may influence their value systems for the rest of their lives (Hutchison, 1998).

Use of programs ranging from focused museum and nature center exhibits, to curricular vehicles adopted by private and public school systems have been recommended as a way to improve students' environmental ethic (Filho, Murphy and O’Loan, 1996). Even federal legislation has been passed to address this issue. According to the Sierra Club's web page, the 1990 National Environmental Education Act, Public Law No. 101-619, includes a mandate that the Environmental Protection Agency establish and operate an environmental education and training program. This act was
reinvigorated after the original National Environmental Education Act was repealed as part of a budgetary reconciliation in 1981. Currently, Congress is deliberating on a reauthorization of the bill (http://www.sierraclub.org/education/neea.htm).

The goal of this thesis project is to investigate the ability of a uniquely configured environmental education program to positively influence the value system, as it relates to environmental responsibility, of sixth and seventh grade students in an urban middle school. This project will include the use of materials and procedures developed in the TNRCC Texas Watch program (developed to enhance grass roots level public environmental action), as well as highly appealing strategies and processes designed to foster middle school students' attention and interest. The program was structured around an extracurricular environmental club at the school where the researcher taught. Additionally, this project included an investigation into the use of the Children's Environmental Attitudes and Knowledge Survey (CHEAKS) as an appropriate evaluation instrument for environmental education programs that have a less than comprehensive focus.

The assessment of CHEAKS included a comparison of the use of the entire survey to using a modified (or subset) version to match the William James Middle School (WJMS) program’s content. The point of this comparison is to answer the question: If the total CHEAKS survey results show no significant effect from the educational program on students' environmental attitudes and knowledge, could the results from the subset of CHEAKS questions show significant effects from the treatment? Could the WJMS program affect a student's environmental attitude or environmental knowledge about
water quality issues without affecting both attitudes and knowledge about all other surveyed environmental issues equally?

Description of the Study

A sample of sixth and seventh grade students at William James Middle School will be exposed to an enrichment science curriculum based on field work in environmental science, particularly aquatic toxicology. The curriculum of the program will be loosely based around the TNRCC's Texas Watch program with additional technological components included as well as a curriculum of high interest level activities.

The students' environmental knowledge and attitudes will be measured before and after the course. A similarly structured control group will be measured concurrently. The control group will not be exposed to the enrichment course.

The measuring instrument will be the Children's Environmental Attitude and Knowledge Scale (CHEAKS). Members of the University of Memphis' Department of Psychology constructed the CHEAKS carefully over several years. It was designed as a flexible evaluation instrument that would possess acceptable levels of reliability and validity when assessing the environmental attitudes and knowledge of children. The flexibility allows these assessments to be made in a variety of situations while measuring the effectiveness of various methods of environmental education (Leeming, et al., 1995).
Hypothesis one: The level of environmental responsibility, as measured by the CHEAKS Total Scale, of sixth and seventh graders at William James Middle School (WJMS) will not be significantly impacted by an extracurricular environmental education field science course. (p <= .05)

Hypothesis two: Environmental attitudes, as measured by the CHEAKS Total Scale, in sixth and seventh graders at WJMS will not be significantly impacted by an extracurricular environmental education field science course. (p <= .05)

Hypothesis three: Environmental knowledge, as measured by the CHEAKS Total Scale, in sixth and seventh graders at WJMS will not be significantly impacted by an extracurricular environmental education field science course. (p <= .05)

Organization of the Thesis

The thesis is organized into five chapters. After Chapter I, in which the scope and purpose of the study are defined, four additional chapters are presented. Chapter II presents a review of related and specific research pertaining to teaching and evaluating environmentally responsible behavior. Next, Chapter III discusses the selection of subjects, educational strategies, the evaluation instrument development and design, the administration of the instrument, and the treatment of data. Chapter IV contains the results of the data analysis. Finally, Chapter V presents a summary of the study, the conclusions which were drawn concerning the hypotheses, and recommendation for further study.
Related to the problem of determining the level of effect that an environmental education program can have on young adolescents in a school setting, the review of literature will focus on the following areas for background information.

1) Mention of the beginnings of environmental education from a global perspective

2) Current sociological and psychological theories related to the development of environmentally responsible behavior as well as the gaps in our understanding of this phenomenon

3) Various recent approaches to environmental education

4) A description of the construction and validation of the Children’s Environmental Attitudes and Knowledge Survey (CHEAKS) assessment tool and a comparison with this study’s classroom structure.

5) A brief overview of pedagogical theories on learning and how successful educational programs incorporate these theories into practice

6) Methods used by the WJMS teachers that incorporate recent theoretical findings and strategies into a newly designed environmental education program.
In this study, questions being asked are: Can the level of a young person’s environmental responsibility be improved through a specific strategy of educational methods? Is it possible to fundamentally change the attitudes that individuals have about the natural world through educational efforts?

It is a question that has been investigated by many researchers, who have studied a plethora of techniques, used by numerous teachers and educators, trying to deduce the answer. It is a question that requires consideration of many components during analysis to come close to a complete answer.

Methods have been developed to answer the question with evaluation tools and analysis instruments. These instruments frequently attempt to analyze the attitudinal growth of participants that have taken part in environmental education programs. Usually, this analysis of growth is done in a pretest / intervention / posttest study design.

The pedagogical methods used by the teachers and educators attempting to answer this question of environmental attitude growth have included attempts to educate students in diverse ways. They tried to accomplish the goal of reprioritizing (improving) their students’ levels of environmental responsibility. And following the attempts at environmental education, the researchers usually evaluate the efforts while looking for clues of whether the intervention used was successful at affecting the learner in the anticipated manner.

Another question being investigated in this study is: Can the Children’s Environmental Attitude and Knowledge Survey (CHEAKS) be utilized realistically to
measure the effectiveness of an environmental education program? Is the survey instrument designed in such a way that it can be applied to a variety of these types of educational programs taught in a variety of settings?

Environmental Education History

The significance of environmental education has been widely recognized for about 25 years, though views vary as to when the words environment and education were first used together. Disinger (1983) writes that the term was used in 1948 at a meeting in Paris of the International Union for the Conservation of Nature and Natural Resources (IUCN). Yet only since the late 1960's has environmental education been actively debated and promoted globally. A landmark IUCN/UNESCO (United Nations Educational, Scientific, and Cultural Organization) meeting on “Environmental Education in the School Curriculum,” held in Nevada, USA, in 1970, arrived at a definition that was widely adopted around the world:

“Environmental education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture, and his biophysical surroundings.” (IUCN 1970).

Current Sociological and Psychological Theories

Questions being posed by environmental education researchers arise as world population overwhelms resources of the planet, yet average Americans maintain their lifestyles without considering the environmental repercussions for many of their actions.
The questions take on more significance as recent research has shown that individuals' behavior towards nature may not always reflect their attitudes about the environment (Bazerman, et al., 1996). At times, even people who have positive feelings for the environment act in ways that actively degrade it. Their behavior is destructive although their feelings are pro-environmental. There exists an "attitude/behavior gap" concerning environmental issues (Bazerman, et al., 1996). Studies have shown that environmental education programs that only stress awareness and knowledge do not necessarily change environmental attitudes and behaviors that have negative impacts on the natural world (Bazerman, et al., 1996). Educators that hope to improve students' levels of environmental responsibility must strive to incorporate attitudinal components into their teaching methods.

It has been noted that making individuals aware of environmental problems is not sufficient to keep them from contributing to environmental degradation much less to have them make positive strides towards improving the natural world, improvements that lessen the damage already done by humans (Bazerman, et al., 1996). Any efforts to redirect environmental attitudes must do more than point out problems and hope for the best. Instead, the solution must take into account the nature of human feelings and how they are derived. It must focus on refining what makes someone see value in their environment and behave accordingly (Bazerman, et al., 1996). Ideally, effective environmental education efforts include components that help individuals see this value.

Hines, et al. (1986) reported that "support has steadily grown for some time among environmental educators for the importance of developing individuals who behave
responsibly toward the environment. This support has grown to such an extent that it can now be said that the development of environmentally responsible and active citizens has become the ultimate goal of environmental education. One of the major impediments to the accomplishment of this goal stems from a lack of knowledge of those factors which have formative effects on the development of environmentally responsible behavior.” (Hines, et al., 1986).

Researchers have studied a great amount of factors which may potentially affect the ability of students to develop environmentally responsible behavior. At the time of their study, Hines, et al. (1986) determined that no complete agreement was in place as to which factors had the greatest influence. However, it was noted that this knowledge is vital in designing successful environmental education programs.

In the “Analysis and Synthesis of Research on Responsible Environmental Behavior: A Meta-Analysis” Hines, et al. (1986) analyzed one hundred twenty eight studies dealing with environmental behavior research which had been reported between 1971 and 1986 in an effort (1) to identify those variables which the research indicated were most strongly associated with responsible environmental behavior, (2) to determine the relative strengths of the relationships between each of these variables and environmental behavior, and (3) to formulate a model of environmental behavior representative of the findings synthesized in this research.

The following variables, taken from surveyed results, analyzed by Hines, et al. (1986) did, or did not, show an effect in influencing environmentally responsible
behavior. (Note, however, that what people indicate on a questionnaire is often inconsistent with their actual behaviors)

- Individuals with greater knowledge of environmental issues and/or knowledge of how to take action on these issues were more likely to have reported engaging in environmentally responsible behaviors than those who did not possess this knowledge.

- Individuals with more positive attitudes (feelings with regards to various aspects of the environment) were more likely to have reported engaging in environmentally responsible behaviors than were individuals with less positive attitudes.

- Individuals who have an internal locus of control (the perception of whether or not he or she has the ability to bring about change through his or her own behavior) were more likely to have reported engaging in environmentally responsible behaviors than were individuals exhibiting a more external locus of control.

- Those individuals who express an intention to perform some action related to the environment were more likely to have reported engaging in environmentally responsible behaviors than were individuals who had expressed no such intentions.

- Those individuals who felt some degree of personal responsibility toward the environment were more likely to have reported engaging in environmentally
responsible behaviors than were individuals who held no such feelings of responsibility.

- There appeared to be little if any correlation between an individual's income level and his or her having been engaged in environmentally responsible behaviors.

- More highly educated individuals were only slightly more likely to have reported engaging in responsible environmental behavior than were less educated individuals. The directionality of the relationship was questionable.

- There is little evidence that one's age affects the likelihood to have reported engaging in environmentally responsible behaviors.

- There is no relationship between gender and the likelihood to have reported engaging in environmentally responsible behaviors.

Results from actual classroom strategies analyzed by Hines, et al. (1986) which included emphasis on a combination of the following factors were successful in increasing the incidence of environmental behavior: knowledge of environmental issues, discussions of alternative solutions to environmental problems, the development of issue investigation skills, environmental problem-solving skills, values discussions and action taking skills. Additionally, programs that were of short term exposure, such as one-day long, were ineffective in encouraging the development of responsible environmental behavior.
Recent Approaches to Environmental Education

Multitudes of programs in environmental education have been tried before. Some have been formal with well-defined curriculum and mandatory structure (Ramsey, 1989; Armstrong, 1991); others have included less formal structure and more random exposure to ideas and experiences. The approaches have ranged from methods like modified museum exhibits to special summer camps to enhanced educational curriculums.

"Approaches to environmental education during the last two decades have changed as our understanding of the environment and of the processes of teaching and learning has advanced. Many traditional approaches have been unsuccessful because they were based on narrow perspectives on education, research, communication, and even the nature of the environmental problems we aim to solve. As society moves toward the twenty-first century, the challenge for educators is to develop and engage in more relevant approaches to environmental education that transcend the limitations of past perspectives. Effective environmental education will require global efforts to increase its availability. Its success will depend on how well educators improve its quality and relevance (Palmer, 1997)."

Evaluation Instrument Development

Since the time when the terms environment and education were first linked, efforts have been made to positively influence the way society interacts with the environment through educational means. It was understood by some individuals at the
time that if no change was made in the way humans treated the non-human natural world, we would cause our own extinction and that the exploitive nature of resource use slowly degrades the environment.

Many entities and groups have attempted to improve societies' environmental ethic by using a variety of educational approaches. The approaches have included methods ranging from modified museum exhibits or special summer camps (Christy, 1982), to enhanced traditional educational curriculums for students (Jaus, 1982). Others have focused instead on teacher instruction in environmental education methods (Jaus, 1978). Many, but not all, of the researched approaches include evaluation instruments to measure the effectiveness of each particular program.

The Children's Environmental Attitudes and Knowledge Survey (CHEAKS) is an evaluation instrument developed to help deal with the consistency problems encountered when evaluating dissimilar environmental education programs. In a recent review of 34 studies that attempted to measure the effectiveness of environmental education, it was found that 33 of them incorporated an environmental attitude or knowledge scale designed for children. All but one of these studies employed a project-developed questionnaire to measure attitudes and/or knowledge, that is, a scale was created specifically for each particular study (Leeming, et al., 1993). Since no single scale is widely used to measure children's attitudes toward, and knowledge of, a broad range of environmental issues it is virtually impossible to make meaningful comparisons across these various studies because the comparability of these instruments is unknown (Leeming, 1995).
A group of professors from the psychology department of The University of Memphis, headed by Dr. F.C. Leeming, identified the need for a valid instrument that could quantify results from various educational programs dealing with a variety of environmental issues. The University of Memphis group analyzed many environmental education programs and their included evaluation schemes. Their goal was to find which approaches to environmental education were successful and why so. Also, included in their goal was a determination of whether the evaluation methods were credible.

It was apparent that the evaluation tools used by most of the approaches were flawed in some way. Limited robustness of the instruments used, or incorrect statistical methods employed by the program leaders during analysis, limited the validity of the evaluation procedures used by most of the programs.

Since every program that was examined had a unique emphasis as well as implementation method, it is difficult to find or design a tool that can be used equally effectively in all environmental education programs. The benefit of having a universal evaluation tool would be to achieve consistency in the future evaluation of environmental education programs so that they could be compared with one another more readily. If all environmental education programs could be evaluated with one valid and reliable tool then they could be compared efficiently and effectively to determine the most successful programs among them. These successful programs could be shared, distributed and practiced in multiple settings so that the time, energy, money and other resources needed in developing sound educational techniques would not be wasted in producing inferior programs that could not achieve worthwhile results.
The CHEAKS was designed to accomplish that goal. It was carefully constructed over several years and possesses acceptable levels of reliability and validity (Leeming, 1995). Its construction included several major attitudinal components, including commitment (verbal and actual), behavior, and affect.

As is described in their paper “Children’s Environmental Attitude and Knowledge Scale: Construction and Validation”, Leeming (et al.) explain that the final version of the instrument consists of two subscales, Attitude and Knowledge, and the CHEAKS Total Scale.

The Attitude subscale comprises 36 items that measure students’ attitudes toward environmental issues (12 items reflect verbal commitment, 12 measure actual commitment, and 12 assess affect). These attitudinal items were sampled systematically from six content-dependent subdomains (i.e., two from each subdomain): animals, energy, pollution, recycling, water, and general issues. The Knowledge subscale comprises 30 items that also systematically sample the six content-dependent subdomains (i.e., five items from each subdomain). Finally, a total score is derived from the combination of the scores obtained on the attitude and knowledge scales.

The 36 questions included in the Attitude scale are presented in a 5-point Likert scale-type response format (i.e., very true, mostly true, not sure, mostly false, or very false). The most pro-environmental response to each item is credited 5 points, whereas the least pro-environmental response receives 1-point credit. Possible scores on the Attitude subscale range between 36 and 180, inclusive. Nine of the attitude items, three in each section, are negatively connoted and reverse scored to reduce the likelihood of student response set. Correct response to the 30 Knowledge questions are each credited 6 points; thus, possible scores on the Knowledge subscale range from zero to 180. Possible scores for the CHEAKS Total Scale range from 36 to 360, with higher scores indicating combined positive attitudes and increased knowledge (Leeming, 1995).

Overview of Pedagogical Theories

Individuals, begin the development of this environmental ethic, or level of environmental responsibility, as children. It is learned in a complex fashion. Children
acquire knowledge, or learn, differently at certain stages of their childhood. These stages of moral and intellectual growth are often age dependent and occur in a predictable order, yet the stages vary from person to person. Jean Piaget, a Swiss psychologist experimenting in the first half of the twentieth century, was responsible for many pedagogical theories on how students learn. He first explained that certain time periods in children's development allows them better to handle and understand abstract concepts, moral reasoning, and so on (Forman and Kuschner, 1977). These stages of cognitive development consequently impact the correct sequencing of curricular material presented by teachers and instructors for maximum benefits to student learning. Information and material that is presented when it is beyond the age appropriate level of the learner is not effectively processed by the recipient and consequently lost or wasted on the audience. Effective environmental educators should be aware of current theoretical positions on how individuals learn and at what stages in life students are most receptive to their teachings.

Teachers must present only age-appropriate material to their students and carefully plan the correct timing and sequencing of the presented information if they are to accomplish their pedagogical goals. If efforts are made to teach ideas and concepts that the students are not cognitively ready to process, then what the teacher thinks is teaching will be different than what is getting through to the child.

Teaching age-appropriate material and concepts can be accomplished if the different stages of intellectual and moral development are understood. Piaget and others have divided these stages of development into the following groups:
• Early stage – children between the ages of eighteen months and seven years have a concrete view of their world. They have limited, or no, logical reasoning abilities but can discern mental pictures of things from memory. Much of what they experience is in the discovery mode. They use their physical senses to derive meaning from their environment. The beginning development of their language skills facilitates their explanation of their surroundings and the memories of things experienced.

• Primary logic – in children between age seven and twelve logic becomes a tool in problem solving. Disparate objects can be grouped by similarities and classified effectively. Abstract thinking is not usually present here but objective answers can be reached through the reliance on facts and other concrete pieces of information. Cause and effect relationships can be explored and understood.

• Naïve adult – children in the eleven to fifteen year age group begin to think as adults. Judgements and evaluations can be based on inference at this age. Abstract concepts can be grasped and deductive reasoning can be used as effective problem solving tools. With training and experience, children in this age group can hypothesize using probabilities and correlations. Complex behavior can be analyzed and assessed for value.

• Advanced stage – beginning at the age of approximately fourteen and extending into adulthood, individuals have the ability to develop scientific experiments that manipulate variables in order to test hypotheses of suspected outcomes. Their capacities are far ranging and include all higher thinking activities (Forman, 1977).

For environmental education, or any education for that matter, to be effective it must first be taught at an appropriate level for student comprehension. Additionally, the teaching must reach the learner in a way that he or she can relate to it. It is important that the presented material be given in a fashion relevant to the students’ mental condition or state of cognition.

Pedagogues have defined domains that learning occurs in as well. The three main domains are cognitive (knowledge), affective (attitudes/feelings), and psychomotor
(physical skills). Individuals have varying levels of proficiency in these three domains. Everyone learns to some degree in each domain; however, people usually have a preferred domain in which the learning style is rooted. Some are better able to comprehend material being taught that is directed primarily towards their affective domain, while others absorb new material better when the instructor uses methods that stimulate the psychomotor domain or the cognitive one. A very important aspect of effective teaching strategy includes the use of this knowledge to reach the various strengths of the teacher’s audience. Usually, the most effective instruction methods will incorporate strategies that meet the needs of all the domains, so that all of the students are receiving bits of value at some level in each lesson. Ideally, instructors can design lessons so they can be presented equally in all domains.

Benjamin Bloom, a renowned educational theorist, and other researchers hypothesize that learning occurs in a hierarchy within these domains. According to his hypotheses, achieving proficiency at each level within the hierarchy is important for the complete understanding of a particular concept or skill to be reached. In fact, according to Bloom, a progression must take place through all of the levels for complete learning to occur. Higher levels build upon those beneath them providing a foundation of understanding. It is not necessary that the material be presented in hierarchical order necessarily, but each level within the hierarchy must be addressed at some point for students to have the greatest potential to fully comprehend the new ideas and concepts (Bloom, 1976).
Bloom’s theoretical structure consists of six levels within the hierarchy. Each level requires a greater amount of higher-level thinking plus the utilization of the ones preceding it.

The first level, **Knowledge**, has the retention and recall of facts and information as its emphasis. **Comprehension**, the second level, deals with understanding the meaning of concepts and ideas. **Application** is the next higher level. At this level, the individual puts the information previously learned to use in some way. In **Analysis** ideas and concepts are dissected and mined for meaning as organizational structure and relationships are determined. The fifth level, **Synthesis**, emphasizes creating meaning and new structure from previously learned disparate parts to form a new meaningful “whole”. The final and highest level, **Evaluation**, includes the placement of value from the learner’s perspective using tools of judgement and discernment. It includes both quantitative and qualitative forms (Bloom, 1976).

**Methods used in the William James Middle School (WJMS) program**

The William James environmental club, “The Enviro-Mentals” (described in Chapter III) design included parts of another program - the TNRCC’s Texas Watch project, along with speakers, field trips and student-computer-use to study water quality issues and programs, and the importance of these issues in the students’ lives and natural environment. All of the factors for effective environmental education programs mentioned by Hines, et al. (1986), including the length of exposure in an effective program, were included as part of the WJMS environmental education study. The belief was held that environmentally responsible behavior could be taught if all of the known components for a sound educational experience were in place.

The students involved in the “Enviro-Mentals” can be grouped in the pedagogical “Naïve Adult” stage. They can make inferences from abstract information and can solve
problems deductively from complex issues and information. Strategies utilized in the
WJMS program took advantage of the students' cognitive level of information processing
to develop feelings of ownership in defining observed problems and issues and potential
inherent and reasonable solutions.

Methods that exercised the three learning domains were included in the program
design so that students were exposed to their domain of preference yet were also
stretched to incorporate the learning directed at the other two domains of learning.

The WJMS environmental education program also took advantage of Bloom’s
hierarchical structure of learning. The students involved in the program were exposed to
learning experiences focused at each level of the hierarchy. Ideally, all students would be
able to derive meaning from the material presented to the greatest extent possible.

Data for this thesis covering the WJMS program were collected using the
Children’s Environmental Attitudes and Knowledge Survey (CHEAKS). The CHEAKS
instrument was initially validated during its design stage using data from students that
were taught nature-study by teachers in traditional, non-computerized, classroom settings
(Leeming, et al., 1995). These teachers likely, although not certainly, covered a broader
scope of environmental issues with more traditional resources than did the William James
Middle School (WJMS) program. The validation study researchers from the University of
Memphis left the design of classroom curriculum up to individual teachers. Information
on the scope and types of environmental study that the twenty-one participating teachers
dispensed was not available for analysis. What is known is that of the forty-two teachers
participating in the field study, these twenty-one teachers “systematically provided their
classes with instructional and experimental activities of an environmental orientation during the school year. The remaining teachers did not involve their classes systematically in any special environmental activities (Leeming, et al., 1995).

The club design is meant to include a novel approach that would effectively reach young adolescents of today. It also is intended to be scientifically sound and include a focus on hands on learning about the natural world. It is intended to help students see the value in their environment which would further influence their behavior towards it. Ultimately, the goal is for students to see the intrinsic value of their environment beyond how it will benefit themselves personally. The hope is that they will begin, or continue, the development of an environmental ethic.

“A one sentence definition of environmental ethics is difficult to provide; however, efforts have been made to come to a common understanding of the concept. Most fundamentally, environmental ethics examines how human beings should interact with the nonhuman world around them (Palmer 1997).”

One’s environmental ethic usually reflects the way a person views their place in the natural world. It reflects the appropriate behavior for interacting with the natural environment of their surroundings. Sometimes individuals can experience conflicting emotions in trying to satisfy their biological needs for food and shelter that can cause environmental harm or destruction. An individual’s environmental ethic is a multifaceted product of one’s values, beliefs and attitudes. Understandably, it is usually deep-seated and determined by many factors. The factors can include, among other things, one’s home environment, early childhood experiences, maturity level, educational background,
personality, and moral development. It is defined over a lifetime and can evolve through exposure to new experiences and a variety of influences.

Invariably, any situation or problem that becomes the focus in an environmentally ethical issue will be complex and multifaceted. In order for the issue to be dealt with in a reasonable manner, it must first be completely understood. All of the relevant information surrounding the question must be gathered and closely inspected. Ideally, appropriate environmental education can facilitate the understanding of the complex issues more efficiently.

Environmental education and promoting positive environmental ethics within individuals can play a role in reconciling individual, societal and environmental needs. "There seems to be ... a general concession that the good of animals, of forests, of bioregions, of ecosystems, and of individual species must be weighed by human moral agents as they make decisions concerning personal practice and public policy. An ethic of respect, if not widespread "rights," seems to be arising from a conviction that some sort of "intrinsic value" can be posited for all sorts of lifeforms and their support systems (Smith, 1997)."

Environmental education continues to be analyzed as a method of improving society's level of environmental responsibility. From its beginning thirty years ago, researchers have improved their understanding about how environmental education can be utilized most effectively. A variety of components must be in place for any such program to be effective. Additionally, correct pedagogical practices should be utilized for maximum student learning to take place.
CHAPTER III

METHODS AND PROCEDURES

The goal of this thesis project is to investigate the ability of an extracurricular program to positively influence the value systems of sixth and seventh grade students in an urban middle school, as they relate to environmental responsibility. This chapter describes the methods and procedures utilized to gather data for this purpose and is divided into five sections. These sections include selection of subjects, educational strategies, administration of the instrument, and the treatment of data.

Selection of Subjects

William James Middle School in Fort Worth, Texas is located in a low socioeconomic neighborhood surrounded by a significant number of decaying residences as well as vacant lots that previously contained recently razed structures. Except for the presence of Texas Wesleyan University nearby and a newly begun community rebuilding effort, the overall local climate is depressed. The student body, however, is comprised of students from throughout the city that infuse the school with a great deal of ethnic and cultural diversity. The school maintains facilities for all of its neighborhood children, known as the greater school, as well as housing a high academic oriented college-preparatory magnet program. Top students from across the city, including the immediate
neighborhood, are drawn to apply for acceptance into the renowned magnet program. The diverse nature of the student population there, and the subsequent opportunities available for all of the students, lends a feeling of energy to the campus in the otherwise depressed area. Two distinct groups of students, the magnet school students and the greater school students, share, on paper at least, the campus, but the majority of time, excepting during physical education classes, band, and lunchtime, they remain segregated to different classrooms utilizing different facilities and teachers.

During the study year, the 1997/98 school year, two William James science teachers, one from the magnet school and one from the greater school, sponsored a school club for 6th and 7th grade students interested in nature and the environment. The club sponsors had several goals in mind when developing the club.

The primary goal of the club was to allow students the opportunity to develop a greater interest in science and to improve their science skills of observing, measuring, analyzing and concluding while practicing hands-on experimentation and data collection. Along with the students' improvement of science skills, it was hoped that a greater appreciation for their natural environment would occur. Since these students were exclusively urban and suburban residents, their exposure to natural settings was limited. Any increase in contact with nature could be significant in comparison to what they had experienced up to that time in their lives.

Another goal of the club was to form an avenue for greater exposure between students in the two separate populations than had previously existed. The belief was that this lack of student exposure to the other population sometimes led to problems related to
misunderstandings about the “other half”. Thus, the students would be mixed together in a way that would enable them to interact socially and academically in a small group setting and would let them become familiar and comfortable with students in the other group.

With such goals in mind, the sponsors developed the design of the club and chose the curricular material that would be used during the year. (The club’s design and curriculum materials will be discussed in subsequent sections). Soon after the school year began in August, the sponsors distributed informational fliers (Appendix C) to all of the sixth and seventh grade teachers in the school. Written and verbal instructions about distributing them to all interested students was also supplied to the teachers. These fliers specified the club’s activities and how one could apply to become a member. Concurrently, daily announcements were made via the public address system (Appendix D) to inform students of the new club and how to apply for it.

The application procedure involved students returning the application form (Appendix E) with their signature indicating a desire to participate in the new science club. Along with their signature, one of their parents was required to sign the form indicating that they were aware of the structure of the program. A recommending teacher was also required to sign the application form showing that the student was able to work independently and had an interest in science.

A question arose concerning the need for an application process to join the group. It was concluded that the application procedure was necessary to maintain the club’s membership numbers for the entire year. The sponsors felt that students would make
more serious commitments towards the club if there were some selectivity to its membership. Prior efforts at school eco-clubs had shown that students tended to drop out as the year progressed due to a lack of commitment to the group by its members. Even though little effort was required to be put forth by student members in years past to be a part of the club, and despite intense efforts to maintain high interest level activities, various distractions and other extracurricular commitments made by the students caused a dwindling of membership by the year's end. Past groups that began with forty-five members were reduced to 5 or 6 students by the end of the year.

This application procedure also allowed for an eager waiting list of potential club members to take the place of any member whose waning attendance resulted in their being removed from the club roll. This motivated students to maintain regular attendance and to plan school makeup work for times other than during club meetings which were held at the normal 1 1/2 hour tutorial/lunch period block on Wednesdays.

Since the number of students who submitted applications was greater than could be accommodated by the activities planned in the club design, some selectivity on member acceptance was required. In order to provide for a valid study, both an experimental group and a control group were needed. The experimental group would receive the treatment (participate as environmental club members) and the control group would receive no treatment and would not alter their regular school activity level. The solution was to divide the applicants in half in such a way that no bias would exist in the grouping structure. After all applications of interested students were submitted, the sponsors categorized them based on gender, grade level, and educational program.
(greater or magnet school) and randomly separated them into two groups. The two groups were formed with the final designation listed in Table 1. All of the applicants were sent either a letter of acceptance as a member of the environmental club or a letter notifying them as being an alternate member in the club. Those students that received letters of acceptance as an alternate were informed that spaces in the club might become available if any members failed to fulfill membership requirements, i.e., regular attendance. Two students did drop out within the first two weeks. Their data is not reflected in the study. Their alternates were included in the numbers listed below.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESCRIPTION OF STUDENTS PARTICIPATING IN THE STUDY</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group (Total number)</th>
<th>Gender</th>
<th>Curricular program</th>
<th>Grade level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Magnet</td>
</tr>
<tr>
<td>Experimental (club members) 17</td>
<td>5</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Control (non-members) 15</td>
<td>4</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

**Educational Strategies**

In addition to their regular school day the students in the experimental group became members of the school environmental club. The control group merely maintained
a regular school day schedule. Provisions for equal representation of gender, age, and curricular program were taken into consideration after which the groups were filled randomly.

The “Enviro-Mentals” was the student-selected name of the environmental club at William James Middle School during the 1997-98 school year. It met weekly on Wednesdays during school hours at the lunchtime/tutorial period block for one hour and twenty minutes. Since that time slot was reserved for student discretionary activity, the club was voluntary and extracurricular. Club sponsors included one sixth grade and one seventh grade science teacher. Out of the thirty-six weeks in the school year, the group met during twenty-seven of them. Buffer weeks at the beginning of the year were planned to facilitate the normal new student orientations and the club’s application process. The club concluded two weeks prior to summer break for end-of-school related activities and final tests week.

The purpose of the club was to provide the opportunity for interested students to experience field science work while developing an understanding of water quality issues. Additionally, the club members would be using current computer and Internet technology while incorporating their new environmental science knowledge in communicating information to peers on the World Wide Web. This club would allow students to perform real world scientific data collecting while using equipment and techniques that are beyond the scope of any traditional classroom curriculum’s scope. Data collected would develop intrinsic meaningfulness to their world since it was closely linked to their schoolyard environment. Prior to undertaking data collection efforts in the field, students
in both groups were evaluated with the assessment tool CHEAKS described fully later in the chapter.

Field Work

The equipment and techniques used for field work in water quality data collection were taken from the Texas Natural Resource Conservation Commission's (TNRCC) Texas Watch program. The TNRCC has a web site devoted to this community involvement activity.

As described in TNRCC's web page, at www.tnrcc.state.tx.us/txwatch/index.html, the program is one that trains monitors to collect information on five water quality variables along with the environmental conditions at their monitoring site. Those variables are water temperature, pH, dissolved oxygen, conductivity or salinity, and water clarity.

- **Water Temperature** affects feeding, reproduction, and the metabolism of aquatic animals. In addition, temperature affects the solubility of compounds in water, distribution and abundance of organisms living in the water, rates of chemical reactions, density inversions and mixing, and current movements.

- **pH** is an indication of the water's acidity. pH measurements run on a scale of 1.0 to 14.0. Solutions with a pH below 7.0 are considered acids; those above 7.0 are considered bases. The pH scale is logarithmic, which means that pH 6.0 is ten times more acidic than pH 7.0, and pH 5.0 is 100 times more acidic than pH 7.0. A range of pH 6.5 to pH 8.2 is optimal for most organisms.

- **Dissolved Oxygen** is the oxygen freely available in water, and is vital to fish and other aquatic life. Oxygen is transferred from the atmosphere into surface waters and is produced by aquatic plants, algae and phytoplankton as a by-product of plant photosynthesis. Once dissolved in water, oxygen diffuses very slowly and distribution depends on the movement of aerated water from turbulence and currents caused by wind, water flow and thermal upwelling. Traditionally, the level of dissolved
oxygen has been accepted as the single most important indicator of a water body's ability to support desirable aquatic life.

* **Total Dissolved Solids & Conductivity** - Total dissolved solids (TDS) is defined as the quantity of dissolved material in water, and depends mainly on the solubility of rocks and soils the water contacts. A convenient way to measure TDS is to test the conductivity of the sample. Conductivity is a measure of the ability of water to pass an electrical current and is affected by the presence of dissolved solids. As level of TDS rises, the conductivity will also increase.

* **Salinity** is the total of all salts dissolved in water, usually expressed in parts per thousand (ppt). Salinity is a term that usually refers to waters receiving marine inflow such as bays and estuaries. In an estuary, the flow of fresh water from streams and rivers mixes with salty ocean water, producing a range of salinity from 0 to 35 ppt. The salt content of water affects the distribution of animal and plant species according to the amount of salinity they can tolerate.

* **Water Clarity (or Turbidity)** - Materials mixed and suspended in water reduce its clarity and make the water turbid. Turbidity is a measure of water clarity, specifically, of how much the solid matter suspended in water decreases the passage of light through the water. In addition to blocking out the light needed by submerged aquatic vegetation, suspended sediment can carry nutrients and pesticides throughout the water system. Suspended particles near the water surface absorb additional heat from sunlight, raising surface water temperature. Settling sediment can bury benthic (bottom dwelling) creatures and fish eggs.

* **Additional Environmental Observations** include algae cover, water color, water clarity, flow level, water surface, water conditions, water odor, present weather and rainfall accumulation.

The club sponsor went through the required training program, which included the designation of a stream sampling site, TNRCC provided him with a monitoring kit that contained all of the necessary instruments and chemicals needed to perform tests on the aforementioned variables. Subsequently, the lead sponsor provided training for the other sponsor and students in all of the testing techniques. Students then put to practice these learned techniques at each sampling trip to the stream. The stream that the students used was located in Sycamore Park a few blocks from the school with the sampling site being at the overpass intersection of the stream and East Vickery Boulevard (see fig. 1). It was
in a location that could be readily and safely reached within the time limitations of the activity period. Liability for accidents was a continual concern so all necessary safety precautions were observed. The sampling stream is a small tributary of the West Fork of the Trinity River.
FIGURE 1

STUDENTS MEASURING TURBIDITY AT CREEK SAMPLING SITE
Replication samples were run on each variable and averaged together to allow each student to refine their sampling techniques through practice and for the sampling to reflect good scientific technique (replication). Students were assigned two or three specific tests for which they were responsible each visit.

The students measured the variables in one-month intervals and collected data prior to, during, and after storm events to develop an appreciation of how those variables can fluctuate depending on the storm events' timing. Over the entire school year the students sampled and monitored variables seven times in seven months.

Additionally they practiced their techniques once at a lacustrine site when they collected data during the year-end lake trip to Lake Worth in west Fort Worth. This change in sampling environment allowed students to experience water depths and clarity previously not encountered at the stream site. Methods of sampling the water turbidity with the secchi disk were the main observed difference. Rather than wading into the stream or sampling from the stream's overpass a pier was used to obtain accurate turbidity readings with the secchi disk (see fig. 2).
Guest Speakers

Scientists from the Fort Worth Environmental Management Department spoke at the club meeting on week nineteen. They presented information on point and non-point source water pollution and ways that citizens could help lessen the problems through wise use of fertilizer, pesticides, and other chemicals present in our environment. They provided a tour of their mobile stormwater-monitoring lab and allowed the students to investigate the ways that their student work was similar to the scientists’ efforts in monitoring water quality.

During the presentation, scientists explained their use of bioassays in monitoring local stream water quality. Additionally, they elicited the club’s help in community education. The “Enviro-Mentals” agreed to label all of the storm drains near the school
campus with city-provided permanent plaques (see fig. 3). The plaques show a fish silhouette with the message "Don't Dump - Drains To Creek" on them.

FIGURE 3
"ENVIRO-MENTALS" LABELING STORM DRAINS
Lab Work

The “Enviro-Mentals” participated in a multi-week bioassay laboratory investigation based on a write-up in *The American Biology Teacher* (Havel, Barnhart and Greene, 1997). *Daphnia magna* were used as the biological specimen in the bioassay. A variety of common household toxins, the ones that students thought might make their way into the local stream, were tested in serial dilutions for their LC$_{50}$ effects (see fig. 4). The toxins included Miracle Grow ® fertilizer, window cleaner, used motor oil, linseed oil, bleach, a liquid root stimulator, and powdered laundry detergent in solution.
FIGURE 4
"ENVIRO-MENTALS" STUDENTS PREPARING SERIAL DILUTIONS
Computer/Internet Activities

Interspersed with the Texas Watch activities, students were exposed to the use of the science computer lab. The lab consisted of multiple networked computers with an ISDN Internet connection through the FWISD’s LAN (see fig. 5).
Students were instructed on Internet web browsing, e-mail, and web page authoring by the school’s computer science instructor as well as the club’s teacher sponsors. As the school year progressed and the students began developing a set of sampling data, they created a page on the school’s web site to publish their results and analyses. The club members also designed linked pages that explained what their club was about and what kind of activities they participated in as well as the data they collected for viewer information.

Originally, the design of the club included having the students to interact via e-mail with a cooperating aquatic toxicology professor, Tom Waller, at The University of North Texas (UNT). Waller agreed to act in a mentor capacity to respond to student questions and direct their sampling analysis for maximum understanding of what their results really meant. Unfortunately, the district’s mail program was not capable of handling out-of-district correspondence as had been initially understood. Consequently, the mentoring was unavailable as planned.

Field Trips

The “Enviro-Mentals” participated in three off-campus field trips to enhance their environmental education experience. On the eighth week of the schedule, the club got permission to leave school and travel to the Rolling Hills Water Treatment plant in south Fort Worth. This treatment plant treats the water from the water sources before it enters the communities’ water systems. The plant operators there supplied the group with a facility tour and informational presentation surrounding the dynamics of urban water use.
On week thirteen, the group visited the Village Creek Wastewater Treatment Plant. This facility treats the communities' wastewater before discharging it back into the Trinity River. The plant operators at Village Creek also provided a facility tour and informational presentation session.

A scheduled field trip to the UNT aquatic toxicology lab was cancelled due to problems surrounding their move to new facilities on campus.

The final trip involved a day-long visit to Lake Worth in west Fort Worth as the last club's last meeting. While at the lake the students completed their final sampling activity. The students were also able to recreate and enjoy the natural setting of the lake environment on the outing.

Administration of the Instrument

The Children's Environmental Attitudes and Knowledge Survey (CHEAKS) was administered to all of the students in the WJMS study, both the experimental group and the control group, in a pretest – posttest fashion. The pretest was given at the beginning of the treatment. The posttest was administered after the program was complete. Table 2 contains an overview of the schedule.

The “Enviro-Mentals” club members responded to the pretest CHEAKS instrument at their second meeting. No time limit was set for completing the survey but a few of the younger students were not able to respond to every question in the allotted time. These three students were allowed to continue at the next club meeting until they finished.
The students in the control group were asked to complete the pretest survey instrument during either their science class period or tutorial period on the same date. The instrument was given to their individual science teachers to distribute and pick up on completion.

Similarly, the posttest was administered to both groups concurrently. The "Enviro-Mentals" club members completed the instrument at the end of the day of their last meeting in the spring. The control group filled out the posttest survey on the same day. They followed the same procedure as they had previously through their science or tutorial class. Two of the students in the control group completed the survey soon after the assigned day, but within the week, due to absences from school.
### TABLE 2

**OVERVIEW OF DATA COLLECTION AND TREATMENT PERIODS**

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest Data Collection Instrument and Day</th>
<th>Treatment and Period</th>
<th>Posttest Data Collection Instrument and Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>CHEAKS, 2nd club meeting</td>
<td>Enviro-Mentals club member 10/9/97 - 5/12/98 27 club meetings</td>
<td>CHEAKS, last club meeting meeting no. 27</td>
</tr>
<tr>
<td>Control</td>
<td>CHEAKS, day of 2nd club meeting (science/tutorial period)</td>
<td>No intervention strategy received, Students maintained normal school curriculum</td>
<td>CHEAKS, day of last club meeting (science/tutorial period)</td>
</tr>
</tbody>
</table>

**Treatment of Data**

Data were analyzed by hand. Each question on each survey was scored individually. Point values were assigned according to the individual question being surveyed.

Those questions in the Knowledge portion of the survey had a potential of six points for each correct response. The questions in the Attitude portion of the survey were valued on a Likert scale-type with possible points ranging from 1 to 5 depending on the response given. All of the surveys were graded consistently for questions left blank. For example, if a knowledge question was left unanswered by a student, it was counted...
incorrect. If an attitude question was left undone, it was evaluated as a neutral response on the Lickert scale (3 pts out of a possible 5 pts).

A CHEAKS score of 108 is the benchmark for determining a positive or negative environmental attitude and knowledge level. An individual choosing "not sure" (3 points) for every attitudinal question (36 in all) and not answering any of the knowledge questions correctly (zero points) would score 108 (3 x 36) points out of the 360 point total possible. Individuals scoring above or below the "neutral" 108 points would be considered either pro- or anti-environmental respectively. Individuals with the highest pro-environmental leanings would be expected to score close to 360 points.

After the surveys from each student were scored, the individual subsets, both the Attitude and Knowledge scale results, of the survey were subtotaled and analyzed separately. The overall CHEAKS Total scale score was subsequently determined by totaling the two subtotals.

**Use of the Entire Instrument**

Since the WJMS program used the CHEAKS instrument as an evaluation tool, a comparison between the Leeming, et al., CHEAKS validation study and the WJMS program, both based on the entire CHEAKS survey, was appropriate. Since the CHEAKS validation study compared pretest and posttest results from students just as the WJMS study did, albeit on a more limited scale, a valid comparison could be made between the results of the two investigations. Similarities in results would lend confidence that the WJMS study was valid even though the sample size in this study was small by design. A
determination about the WJMS program's potential value might be made if its results closely reflected the validation study results. Conversely, these comparisons between studies would be invalid if the results being considered were substantially different from each other. Comparable statistical means, along with comparable standard deviations, from both studies' would help to show that results from the WJMS program are valid for analysis (Table 4). The data could reflect that the WJMS environmental education program was a worthwhile enterprise.

Before comparing WJMS data with the Leeming data several points must be taken into consideration. In the Leeming study, students were divided into two different age groups. One group was composed of 1st through 3rd graders and the second group included 4th through 7th graders. It should be noted that reasonable comparisons should only be made with Leeming's older group since its composition more closely matches the WJMS group, at least in terms of age, which is the only defining criteria given for Leeming's data.

Also, the number of students participating in the CHEAKS validation study was substantially larger than the WJMS sample. The CHEAKS validation study group included one thousand forty one students. Of that number, nine hundred eleven of them were in the older age group studied by the University of Memphis' team.

**Use of a Modified Survey**

The CHEAKS survey instrument was designed to evaluate students' change in attitudes and knowledge covering a wide range of environmental issues. If an
environmental education program’s design was limited in focus, as the WJMS study was, problems with the justification of the CHEAKS as a proper evaluation instrument may exist. Since the scope of the WJMS program was limited, potentially only a few of the survey questions were appropriate in determining any effect of intervention efforts. Any change shown on the results of the entire survey instrument would not necessarily be due to the educational strategies used, but instead to other factors in the students’ lives that could not be directly attributed to the treatment. With the understanding that only a portion of the instrument was reflected in the curriculum of the WJMS extracurricular environmental education activity, a subset of CHEAKS questions was defined that closely paralleled the instruction and activities involved in the WJMS program (Appendix F).

Results on the subset of CHEAKS questions, questions related to water quality, were tabulated and compared (Table 3). This analysis was done in order to determine if the CHEAKS Total Scale scores would deviate significantly from the students’ scores on the questions related to the curriculum of the WJMS program. If a greater difference between the scores of the experimental and control groups existed on the abbreviated survey than on the total one, the value of using the CHEAKS instrument in disparate programs with differing focuses would diminish. If the use of an abbreviated survey like the one used here could show greater differences than with the use of the entire survey, then the reliability of the CHEAKS as a universal evaluation tool for environmental education would be questioned.
An analysis of how students answered the subset of survey questions and the results of analysis of their answers on the abbreviated survey were tabulated (Table 3). Any statistical data generated from this subset of survey questions cannot, however, be reasonably compared with the greater body of information produced by the CHEAKS validation study due to the differing nature of the questions asked. Instead, the subset scores have only been compared with results of the total CHEAKS scores for the WJMS group.

Scale scores were subjected to statistical analyses, The Instituut voor Foneitische Wetenschappen (Institute of Phonetic Sciences) of the University of Amsterdam provides statistical testing via the Internet to facilitate research being conducted by its students. The statistics test web site (http://fonsg3.let.uva.nl:8001/Service/Statistics.html) is also available to the general public for their research needs. The site was utilized to determine the statistical significance of differences in the tested samples.

Due to perceived problems (small sample size) and no assumption of normality of the samples, the non-parametric Wilcoxon two sample test was applied. Tests comparing the results between the experimental group and the control group were applied in three sets. Results were compiled in the comparison between 1) attitude level changes, 2) knowledge level changes and 3) changes in the overall knowledge and attitude levels of the control and experimental groups. The resulting probabilities were two-tailed in nature. A p-value <= 0.05 was used to determine statistical significance.
CHAPTER IV

RESULTS DISCUSSION

To determine the effectiveness of an environmental education activity used in an urban middle school, an environmental attitude and knowledge survey was administered to student participants in this study. Members of the school's environmental club, and other students in a control group, responded to the survey before and after their participation in the school-year-long educational program during 1997-98.

Chapter IV contains statistical analysis of the findings. It is divided into two sections. The first part summarizes how data was collected, including the group structure, program design and how participants were evaluated. The final section presents statistical analyses of the overall results of the survey and a discussion of the findings.

Group Structure

The data presented in this chapter were obtained from thirty-two sixth and seventh grade students at William James Middle School. The students were divided between an experimental group receiving treatment and a control group with no treatment. The groups were separated into evenly matched samples with awareness of gender, grade level, and curricular program, magnet or regular, determining the makeup of each group. The students in the experimental group were all members of the school's nature club,
"The Enviro-Mentals". The control group students had no participation in any extracurricular environmental/nature study program.

There were a total of seventeen Enviro-Mentals Club members and fifteen non-members that were surveyed and participated in the study. As noted, the two groups were divided in such a way that balance was maintained.

Program Design

Since the goals of the school program were to provide an extension of the normal science curriculum to as many students as possible given available resources, certain modifications in the program design were necessary. Initially, the school program was intended to revolve solely around the procedures and principles of the TNRCC’s Texas Watch program. However, in order to take advantage of pedagogical strengths of sponsors, to deal with the restrictions of the campus’ urban location, and to utilize technological assets at the school setting, a qualified, albeit equally effective, program emerged in its place.

Consequently, the Enviro-Mentals club’s focus was narrow in terms of the scope of environmental issues being emphasized. However, the technological component of the club expanded the overall coverage of topics beyond that which most school nature clubs have.

Evaluation Method

The CHEAKS instrument that was used in both the Leeming study and the WJMS study was a problem for some of the subjects in the WJMS study. Several students with
lower reading levels struggled with vocabulary and asked for assistance in understanding what was being asked by the survey. They were instructed to do the best they could without teacher assistance. Several students were unable to finish due to factors such as time limits, a lack of interest and motivation or possibly fear of failure. There was no information concerning similar incidents related to the Leeming study. Consequently, results of the survey were not entirely complete for two students in the WJMS study. Even though these students failed to answer all of questions in the evaluation tool, their surveys were scored consistently along with the others. If a knowledge question was left unanswered by a student, it was counted incorrect. If an attitude question was left undone, it was evaluated as a neutral response on the Liekert scale (3 pts out of a possible 5 pts).

Necessarily, results reached in the WJMS program that are compared to results garnered from the Leeming study must be weighed with certain understandings about differences between programs. With these understandings in mind, analyses of data have been approached from two different directions. One method of analysis included the entire survey instrument as was intended by its authors. The second method utilized a modified survey to address specifics found in the WJMS environmental education program.

Statistical Analyses and Findings

Several types of analyses were made with the data set provided by the study. A variety of visual inspections were initially used in assessing the data. Utilizing both
experimental group and control group results, the initial CHEAKS scores for each student were subtracted from his or her individual final CHEAKS score. This difference should show the amount of change in the students' environmental attitudes and knowledge over the treatment period.

Initial inspections included examination of histograms composed of differences between pretest and posttest results. Histograms included scores on both the Attitude and Knowledge subscales as well as scores on the CHEAKS Total Scale (see Figures 6 and 7).

A visual inspection of the histograms from the student survey results did not reveal any noticeable trends. Many students improved on their survey scores from pretest to posttest, yet some also declined from pretest to posttest, while others remained consistent with little progress or decline between tests. Consequently, individual values received on pretests and posttests were widely varied and no patterns were discerned.

After determining that no consistent pattern was evident, another comparison was made between means of control and experimental groups on the two subscales and the total scale. Improvements between the first and second sampling were averaged for both the control and experimental group (see Table 3).

When the results were evaluated using the Wilcoxon two-sample statistical tool, additional information was obtained. Since the sample size of the study sample was small, analysis was carried out to determine if the data was normally distributed. Data sets deviated somewhat from normality without showing critical amounts of outliers. A non-parametric test was needed.
Survey Results for Control Group

FIGURE 6
Survey Results for Experimental Group

FIGURE 7
Due to the non-normal sample distribution, a non-parametric tool was required to test statistical significance of differences between experimental and control groups. The Wilcoxon two-sample test was utilized. The Wilcoxon two-sample test was chosen due to the nature of the data collected. According to information provided on the World Wide Web by the University of Amsterdam's Institute of Phonetic Sciences' statistics web page, the Wilcoxon two-sample test is "a most useful test to see whether the values in two samples differ in size. It resembles the Median -Test in scope, but it is much more sensitive. In fact, for large numbers it is almost as sensitive as the two sample Student t-test. For small numbers with unknown distributions this test is even more sensitive than the Student t-test. As it is on rare occasions that we do know that values are normally distributed, this test is to be preferred over the Student t-test (http://fonsg3.let.uva.nl:8001/Service/Statistics.html)."

Results obtained from the CHEAKS Total Scale score show that the students who received treatment, those who were part of the extracurricular Enviro-mentals Club, had a slight overall improvement between the pretest and posttest results. Overall, their level of environmental responsibility improved as a group. While some of the participants declined in score, and some scored equally on both pretest and posttest, 59% of the experimental group students improved their score over the treatment period. An average of the differences between the pretest and posttest scores for all of the experimental group participants showed an overall average increase of 20.18 points out of a possible 360 points, or an average increase of 5.7% in their level of environmental responsibility.
However, when the Total scale is separated into Attitude and Knowledge scales it became obvious that improvement for most students in the experimental group was due to an increase in environmental knowledge rather than in environmental attitude. The Knowledge scale subset mean improved 21.88 points, or 12.2 %, while the Attitude scale subset mean actually declined 1.71 points, or 0.95% (Table 3).

The students that did not participate in the “Enviro-Mentals” also showed an increase or improvement between the scores on the CHEAKS Total Scale pretest vs. posttest. On average, their scores improved an average of 9.33 points, for an increase of 2.6% (Table 3). Individually, 46% of control group students improved on the posttest while the remaining students did worse on the posttest or remained consistent with their pretest score. As a whole though, the nonparticipants did not improve as much in their score, or level of environmental responsibility, as the participating students did. The amount of environmental responsibility improvement of the “Enviro-Mentals” was on average double that of the non-participating students (5.7% to 2.6%). However, the gains could be considered marginal.
TABLE 3

AVERAGE SCORES FOR BOTH GROUPS ON INITIAL AND FINAL SURVEYS

<table>
<thead>
<tr>
<th>Analyzed Survey</th>
<th>Group</th>
<th>Initial Score Mean</th>
<th>Final Score Mean</th>
<th>Mean Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total CHEAKS (360 points)</td>
<td>Experimental</td>
<td>215.65</td>
<td>235.82</td>
<td>20.44 (5.7%)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>239.86</td>
<td>248.07</td>
<td>9.33 (2.6%)</td>
</tr>
<tr>
<td>Subset of Attitude Questions (180 points)</td>
<td>Experimental</td>
<td>136.59</td>
<td>134.88</td>
<td>-1.71 (-0.95%)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>140.64</td>
<td>141.43</td>
<td>2.00 (1.1%)</td>
</tr>
<tr>
<td>Subset of Knowledge Questions (180 points)</td>
<td>Experimental</td>
<td>79.06</td>
<td>100.94</td>
<td>21.88 (12.2%)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>95.8</td>
<td>103.13</td>
<td>7.33 (4.1%)</td>
</tr>
</tbody>
</table>

The increased level of improvement by the students in the "Enviro-Mentals" club suggests that the extracurricular program activities result in a positive effect on students' environmental responsibility. According to the data tabulated in Table 3 it is obvious that the experimental group has substantially greater knowledge (12.2% more) about their environment than they did before the treatment was given. This increase in knowledge is likely due to exposure to information given and techniques learned over the course of the "Enviro-Mentals" program.

Difference between control and experimental groups may have been more dramatic if the method of choosing subjects for the experiment were modified. Since all
of the students expressed an interest in being a part of the extracurricular group it must be acknowledged that they were more than likely to have a higher environmental ethic, or interest in nature at least, than the population at large. The amount of change over a year's time may have been less than a student who began with a low environmental ethic, a low positive interest, or negative interest, in the natural environment. One would expect that positive exposure to issues that heighten awareness of environmental problems would improve the level of environmental responsibility of those exposed to them. If students were taken from the general population as members of the group, and the extracurricular group included those with both negative as well as positive feelings about nature, then a greater average amount of improvement of environmental responsibility would have been realized.

When the data from the CHEAKS instrument is reanalyzed using an alternate set, or subset, of survey questions than was intended by its authors, a different perspective can be taken. If the CHEAKS is reduced to a survey dealing only with water quality issues, or questions, a valuable analysis can be made. Since the WJMS program dealt almost exclusively with the water quality type issues presented in the subset of survey questions, it might be expected that the participating students would score relatively higher on the subset than on the total survey. Yet, the scores remained consistent, at least within a few percentage points, for both groups on both the full and abbreviated surveys (Table 5). This fact seems to reflect that the CHEAKS is a valid evaluation instrument for this type of program even though the program's focus was narrow while the evaluation instrument was broad-based. One may interpolate that the CHEAKS is a valid evaluation
(Leeming, Dwyer, and Bracken, 1995) which utilize the relatively new CHEAKS tool, the results generated here give support to using CHEAKS to effectively evaluate environmental education projects. Obviously further efforts should be made in studying the CHEAKS tool to reach a definitive conclusion on its effectiveness, but one may interpolate that the CHEAKS is a valid evaluation instrument for other narrowly focused environmental education programs since it performed effectively in this case. This was the intended goal of the instrument’s authors.

<table>
<thead>
<tr>
<th>Survey</th>
<th>Group</th>
<th>Average difference between final and initial sampling</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEAKS total (360 pts. possible)</td>
<td>Experimental</td>
<td>20.4 points (5.7%)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>9.3 points (2.6%)</td>
</tr>
<tr>
<td>Water Quality subset (68 pts. possible)</td>
<td>Experimental</td>
<td>2.7 points (3.9%)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.3 points (3.3%)</td>
</tr>
</tbody>
</table>

An argument can be made that the small sample size of the WJMS study makes it suspect for valid conclusions to be drawn. However, when a comparison of the WJMS
results with the results from the initial CHEAKS validation study are made, parallels in
the means and standard deviations between the two studies can be observed (Table 5).
These parallels give legitimacy to the WJMS study since the Leeming validation study
is based on a much larger population size.

<table>
<thead>
<tr>
<th>Group</th>
<th>Initial mean</th>
<th>Initial s.d.</th>
<th>n</th>
<th>Final mean</th>
<th>Final s.d.</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leeming - grade 1-3</td>
<td>187.2</td>
<td>30.69</td>
<td>286</td>
<td>194.47</td>
<td>34.35</td>
<td>324</td>
</tr>
<tr>
<td>Leeming - grade 4-7</td>
<td>208.11</td>
<td>38.79</td>
<td>911</td>
<td>212.97</td>
<td>43.43</td>
<td>917</td>
</tr>
<tr>
<td>WJ Enviromentals</td>
<td>215.65</td>
<td>40.26</td>
<td>17</td>
<td>235.82</td>
<td>33.01</td>
<td>17</td>
</tr>
<tr>
<td>WJ Control</td>
<td>239.86</td>
<td>44.62</td>
<td>15</td>
<td>248.07</td>
<td>42.93</td>
<td>15</td>
</tr>
</tbody>
</table>

Means and standard deviations for the Leeming groups and the WJMS groups are
congruous throughout with only slight deviations. The initial and final score means of
both the WJMS experimental and control groups are only slightly higher than those for
either of Leeming's groups (Table 5). The higher means by WJMS students may be
explained by the age difference between the two study groups; since Leeming's group
includes younger children, including students in grades 4, 5, 6 and 7, than the WJMS
group, which included only 6th and 7th graders, a higher mean score from the older
students might be expected. The overall superior scores obtained by the WJMS control
group on both pretest and posttest may be explained by a skewed effect due to the small sample size. Four students in the control group had significantly higher overall scores than their peers, therefore, their results had a significant effect on the groups' values. Additionally, the control group had a proportionately higher number of seventh graders. Another year of formal education and maturation may have given these students greater abilities than those in the experimental group.

Nonetheless, values for initial and final means, as well as initial and final standard deviations, are quite comparable for the WJMS and Leemings groups. Additionally, the improvement from pretest to posttest is consistent for both the Leeming and WJMS groups. These closely matching results give evidence that the WJMS study produced data that are consistent with a study with a much larger sample size.

**Testing of Hypotheses**

Three null hypotheses were tested in this study. The following is a listing of these hypotheses, along with a judgement as to whether each can be rejected or not.

**Hypothesis One.** The level of environmental responsibility, as measured by the CHEAKS Total Scale, of sixth and seventh graders at WJMS will not be significantly impacted by an extracurricular aquatic toxicology field science enrichment course. (p <= .05)

Results on the Wilcoxon two-sample test indicate that there was no significant difference between the improvement of the level of environmental responsibility for the experimental group as compared to the control group (p <= 0.05). Results were similar
whether the scores of all the CHEAKS Total Scale items were analyzed or just the subset of water quality survey items were used (Table 6). Therefore, $H_0$ one is accepted.

**Hypothesis Two** – There will be no significant difference in the improvement of environmental attitude scores between students participating in an extracurricular aquatic toxicology field science enrichment program and those in the control group not participating in the enrichment program. ($p \leq 0.05$)

Results on the Wilcoxon two-sample test indicate that there was no significant difference in the improvement in environmental attitudes for the experimental group when compared to the improvement in environmental attitudes for the control ($p \leq 0.05$). Results were similar whether the scores of all the CHEAKS attitude items were analyzed or just the subset of water quality survey attitude items were used (Table 6). Therefore, $H_0$ two is accepted.

**Hypothesis Three** - There will be no significant difference in the improvement of environmental knowledge scores between students participating in an extracurricular aquatic toxicology field science enrichment program and those in the control group. ($p \leq 0.05$)

Results on the Wilcoxon two-sample test indicate that there was a significant difference in the improvement in environmental knowledge for the experimental group when compared to the improvement in environmental knowledge for the control group ($p \leq 0.05$). Results were similar whether the scores of all the CHEAKS knowledge items were analyzed or just the subset of water quality survey knowledge items were used (Table 6). Therefore, $H_0$ three can be rejected.
<table>
<thead>
<tr>
<th>Survey results being compared</th>
<th>p-value</th>
<th>Significantly different at p &lt;= .05?</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEAKS Total questions score</td>
<td>0.2269</td>
<td>No</td>
</tr>
<tr>
<td>(Final survey score – Initial survey score)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subset-of-CHEAKS Total questions score</td>
<td>0.6504</td>
<td>No</td>
</tr>
<tr>
<td>(Final survey score – Initial survey score)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEAKS Attitude questions score</td>
<td>0.8651</td>
<td>No</td>
</tr>
<tr>
<td>(Final survey score – Initial survey score)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subset-of-CHEAKS Attitude questions score</td>
<td>0.5711</td>
<td>No</td>
</tr>
<tr>
<td>(Final survey score – Initial survey score)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHEAKS Knowledge questions score</td>
<td>0.0378</td>
<td>Yes</td>
</tr>
<tr>
<td>(Final survey score – Initial survey score)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subset-of-CHEAKS Knowledge questions score</td>
<td>0.0011</td>
<td>Yes</td>
</tr>
<tr>
<td>(Final survey score – Initial survey score)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER V

SUMMARY AND CONCLUSIONS

Following the two-semester-long duration of the “Enviro-Mentals” group activity, a variety of conclusions can be drawn. This chapter will briefly explain the justification and objectives of the study, as well as summarize any findings that were attained. Additionally, it will recommend related items for future study.

Justification for the Study

Formal environmental education is rarely included in the average school child’s basic academic experience. The only environmental education many students ever receive is through special outside-of-school activities. It seems an ironic circumstance that this condition exists in current educational philosophy. These courses may ultimately be the key for students to understand how they impact their world, consciously and unconsciously. Yet, due to many forces, including resistance to change, educators as a group have not accepted the responsibility of altering the curriculum that may influence global environmental health.

Since environmental education may be an essential component in a child’s life, pedagogical methods should be explored that would allow students to have exposure to
exposure to this vital science discipline. The exposure may be through formal or informal means. It may be accomplished within the normal educational curriculum or in an extracurricular fashion. Regardless of the method, the importance of the message cannot be overstated. The survival of our species, as well as others, may depend on those individuals that are enlightened in the processes of the natural world. It can only be an enlightenment they get from exposure to environmental education.

Consequently, an in-school program designed to get kids into environmental education was developed, on an extracurricular basis, at a Fort Worth, Texas middle school. The program had several components, but its focus mainly revolved around the study of water quality issues based on the TNRCC's Texas Watch program.

Objectives of the Study

The intent of this study is to determine if a newly designed extracurricular environmental education program can positively affect the level of environmental responsibility of urban middle school students. Can this program which utilizes current computer technologies and hands-on science laboratory and field work influence the environmental attitudes and environmental knowledge of the average twelve and thirteen year old adolescent of today? Also, the study's intent is to determine if is it possible to utilize a single evaluation instrument to assess if this effect has occurred. Can an evaluation tool designed for use in a variety of general environmental education programs be validly utilized in a program that has a somewhat narrow focus?
Findings of the Study

Thirty-two students were involved in the William James Middle School study. They were all evaluated with a statistically valid and reliable instrument, the CHEAKS. Seventeen of them were members of the “Enviro-Mentals” club that met weekly through the year participating in a variety of environmental education activities in addition to their standard school schedule. The remaining group was composed of control subjects that did not modify their normal school activities. All subjects were evaluated in a pretest – posttest fashion with the same analysis instrument.

Wilcoxon two-sample tests were performed to determine the statistically significant differences in overall environmental responsibility level between the two groups on pretest and posttest scores. Analysis of the data, at the 0.05 level of significance, indicated that the participation in the WJMS environmental education program had no effect on the students’ level of environmental responsibility.

Analyses were also made to compare the statistically significant differences between the growth of the two groups in attitudes and knowledge related to the environment. Again, the Wilcoxon two-sample tests were used to determine the level of difference. At the 0.05 level of significance, there was no apparent difference in the amount of growth in environmental attitudes between the two groups. However, there was a significant amount of difference in the development of environmental knowledge. The students who were members in the extracurricular “Enviro-Mentals” club had a perceptible increase in their overall environmental knowledge when compared to the students who did not participate in the educational experience.
All of the aforementioned analyses were accomplished using the CHEAKS as the evaluation instrument. A modified instrument, one that was composed of a subset of the CHEAKS survey questions that more closely reflected the WJMS program emphasis, was utilized as well. The point of the use of a modified survey was to investigate the effectiveness of the CHEAKS for a narrowly focused program like the WJMS one. Each analysis taken with the CHEAKS was matched in statistical level of significance by the modified survey. These mirrored results lend confidence that the CHEAKS can be used as an effective evaluation instrument in a wide range of environmental education programs.

Recommendations for Future Study

Based on the findings and implications of this study, a few recommendations can be offered for future study:

1) The TNRCC's Texas Watch program should be utilized more effectively within the standard school curriculum. Its hands-on/minds-on approach to teaching and learning incorporates current understandings of appropriate strategies to engage young adolescent learners. Its methods, that are grounded in quality scientific techniques, provide benefits not often found in current K-12 science classrooms and textbooks. Multidisciplinary approaches that incorporate effective environmental education along with the Texas Watch program should be developed and studied for future use at many levels within the public school systems nationwide.

2) The value of programs that focus on environmental education for all students should be studied. The fact that students drawn towards elective environmental education
implies a somewhat positive leaning towards environmental responsibility already in place. The potential for substantial improvement in that area is automatically limited due to the already high levels that most students with that inclination already possess. Studies should be undertaken that evaluate how a well-developed environmental education program may effect students with lower levels of environmental responsibility. Will they develop more positive environmental attitudes and increased levels of environmental knowledge after such exposure?

3) Many students at the middle school level are eager to learn about nature and the environment. This study may have been as successful as it was due to the age of the student participants. Studies should be undertaken to determine if there is an optimal age at which environmental attitudes and knowledge could be most affected. Programs like the “Enviro-Mentals” should be carried out and analyzed at both the lower and upper grades in order to determine if all ages of individuals are equally positively influenced about our environment. Equally important is determining the most appropriate pedagogical method to use with the various age groups being taught environmental education.

The need for increased emphasis on environmental education is vital for society to understand its potential for harm to the environment. Unfortunately, there currently exists as great a need for society even to understand that there is such a necessity for this suggested emphasis. It seems like an uphill struggle for the near future, yet one undoubtedly worth humanity’s challenge.
APPENDICES
APPENDIX A

EVALUATION INSTRUMENT
Children's Environmental Attitudes and Knowledge Survey (CHEAKS)

On items 1-36, choose the one of the following choices as your answer:

A - very true
B - mostly true
C - not sure
D - mostly false
E - very false

Attitudes
1. I would be willing to stop buying some products to save animals' lives.
2. I would not be willing to save energy by using less air conditioning.
3. To save water, I would be willing to use less water when I bathe.
4. I would not give $15 of my own money to help the environment.
5. I would be willing to ride the bus to more places in order to reduce air pollution.
6. I would not be willing to separate my family's trash for recycling.
7. I would give $15 of my own money to help protect wild animals.
8. To save energy, I would be willing to use dimmer light bulbs.
9. To save water, I would be willing to turn off the water while I wash my hands.
10. I would go from house to house to pass out environmental information.
11. I would be willing to write letters asking people to help reduce pollution.
12. I would be willing to go from house to house asking people to recycle.
13. I have not written someone about a pollution problem.
14. I have talked with my parents about how to help with environmental problems.
15. I turn off the water in the sink while I brush my teeth to conserve water.
16. To save energy, I turn off lights at home when they are not in use.
17. I have asked my parents not to buy products made from animal fur.
18. I have asked my family to recycle some of the things we use.
19. I have asked others what I can do to help reduce pollution.
20. I often read stories that are mostly about the environment.
21. I do not let a water faucet run when it is not necessary.
22. I leave the refrigerator door open while I decide what to get out.
23. I have put up a birdhouse near my home.
24. I do not separate things at home for recycling.
25. I am frightened to think people don't care about the environment.
26. I get angry about the damage pollution does to the environment.
27. It makes me happy when people recycle used bottles, cans, and paper.
28. I get angry when I think about companies testing products on animals.
29. It makes me happy to see people trying to save energy.
30. I am not worried about running out of water.
31. I do not worry about environmental problems.
32. I am not frightened about the effects of pollution on my family.
33. I get upset when I think of the things people throw away that could be recycled.
34. It makes me sad to see houses being built where animals used to live.
35. It frightens me to think how much energy is wasted.
36. It upsets me when I see people use too much water.
Knowledge
On items 37 - 66 choose the most correct answer to each statement

37. Most elephants are killed every year to provide people with:
   A) trophies.
   B) ivory.
   C) meat.
   D) oil.
   E) skin.

38. Burning coal for energy is a problem because it:
   A) releases carbon dioxide and other pollutants into the air.
   B) decreases needed acid rain.
   C) reduces the amount of ozone in the stratosphere.
   D) is too expensive.
   E) pollutes the water in aquifers.

39. Ecology assumes that man is what part of nature?
   A) special.
   B) related to all other parts.
   C) not important.
   D) the best part.
   E) the first part.

40. Phosphates are harmful in sea water because they:
   A) cause cancer in fish.
   B) stop reproduction in fish.
   C) make fish nervous.
   D) make the water cloudy.
   E) suffocate fish by increasing algae.

41. Compared to other paper, recycled paper:
   A) takes more water to make.
   B) takes less energy to make.
   C) is less expensive to buy.
   D) is harder to write on.
   E) produces more pollutants.

42. The most pollution of our water sources is caused by:
   A) dams on rivers.
   B) chemical runoff from farms.
   C) methane gas.
   D) leaks in the sewers.
   E) human and animal wastes.

43. Ecology is the study of the relationship between:
   A) different species of animals.
   B) plants and the atmosphere.
   C) organisms and their environments.
   D) man and other animals.
   E) man and the environment.
44. The most common poisons found in water are:
   A) arsenic, silver nitrates.
   B) hydrocarbons.
   C) carbon monoxide
   D) sulfur, calcium.
   E) nitrates, phosphates.

45. Where does most of the garbage go after it is dumped from the garbage trucks?
   A) To an aquifer where it is burned.
   B) It is dumped into the ocean.
   C) It is recycled to make plastic.
   D) To a landfill where it is buried.
   E) To farmers for use as fertilizer.

46. Which is most responsible for creating acid rain?
   A) sulfur dioxide.
   B) carbon dioxide.
   C) ozone.
   D) nitrogen.
   E) ultraviolet radiation.

47. Catching tuna in the ocean:
   A) is eliminating a main food source for whales.
   B) protects baby sea turtles.
   C) also kills many dolphins.
   D) is now against the law.
   E) is necessary to keep the population size down.

48. Which is an example of a perpetual energy source?
   A) nuclear.
   B) oil.
   C) wood.
   D) uranium.
   E) solar.

49. Which of the following is the most dangerous to the earth’s environment?
   A) damming rivers.
   B) overpopulation.
   C) tornados.
   D) household pets.
   E) nuclear power plants.

50. Most of the lead in our air is caused by:
   A) cars.
   B) industrial plants.
   C) airplanes.
   D) burning refuse.
   E) cigarettes

51. Recycling means that:
   A) people buy things that can be used again.
   B) more people should ride bicycles.
   C) small children should wear the clothes of their older brothers or sisters.
   D) items should be tested before we buy them.
   E) environmental changes are always taking place.
52. Animals alive today are most likely to become extinct because:
   A) natural selection kills weaker animals
   B) where they live is getting too warm.
   C) they are unable to reproduce because of pollution.
   D) the habitat where they live is destroyed.
   E) their food supply is destroyed by acid rain.

53. Coal and petroleum are examples of:
   A) fossil fuels.
   B) renewable sources of energy.
   C) energy sources that are plentiful.
   D) alternative sources of energy.
   E) recycled resources.

54. Environmental problems are a threat to:
   A) mostly people in small countries
   B) only people in small countries
   C) only wild animals and endangered species
   D) mostly tropical plants and animals
   E) all living things in the world.

55. Which of the following doesn’t do much to reduce the pollution by automobiles:
   A) properly tuned engine
   B) high octane gas
   C) low lead gas
   D) smog control devices
   E) propane engines

56. The main problem with landfills is that they:
   A) take up too much space.
   B) are ugly to look at and smell bad.
   C) attract rats and other pests.
   D) prevent farming of nearby land.
   E) do not produce enough methane.

57. Building a dam on a river can be harmful because it:
   A) makes the river muddy.
   B) can no longer be used to make electricity.
   C) increases level of pollution on the water.
   D) causes the river to flood.
   E) damages the river’s natural ecosystem.

58. Where is water under the ground found?
   A) in landfills.
   B) in ponds.
   C) in low pressure areas.
   D) in aquifers.
   E) in rivers.

59. Killing animals like wolves that eat others:
   A) is necessary and should be done.
   B) may increase the number of other animals.
   C) does not affect other animals in the area.
   D) may decrease the number of other animals.
   E) will help protect the environment.
60. An example of a nonrenewable resource is:
   A) petroleum.
   B) trees.
   C) ocean water.
   D) sunlight.
   E) animals raised for food.

61. Most air pollution in our big cities comes from:
   A) cars.
   B) jet planes.
   C) factories.
   D) big trucks.
   E) landfills.

62. An item which can not be recycled and used again is:
   A) disposable diapers.
   B) newspapers.
   C) aluminum cans.
   D) motor oil.
   E) plastic bottles.

63. What is the main problem with the use of aquifers for a water supply?
   A) They recharge too quickly.
   B) They are becoming used up.
   C) They contain too much fresh water.
   D) They contain too much salt water.
   E) It is hard to get the water out.

64. A species that no longer exists is:
   A) protected.
   B) endangered.
   C) abundant.
   D) extinct.
   E) wild game.

65. Which uses the most energy in an average house in the United States?
   A) lights.
   B) TV.
   C) hot water heater.
   D) telephone.
   E) refrigerator.

66. Which of the following groups is most interested in environmental issues?
   A) Boy Scouts of America.
   B) The Sierra Club.
   C) Kiwanis.
   D) 4-H Club.
   E) The American Cancer Society.
APPENDIX B
EVALUATION INSTRUMENT WITH ANSWERS
Appendix B – CHEAKS with answers and question category

(Attitude scale #’s 1-36, Knowledge scale #’s 37-66)

<table>
<thead>
<tr>
<th>True</th>
<th>Animals</th>
<th>1. I would be willing to stop buying some products to save animals' lives.</th>
</tr>
</thead>
<tbody>
<tr>
<td>False</td>
<td>Energy</td>
<td>2. I would not be willing to save energy by using less air conditioning.</td>
</tr>
<tr>
<td>True</td>
<td>Water</td>
<td>3. To save water, I would be willing to use less water when I bathe.</td>
</tr>
<tr>
<td>False</td>
<td>General</td>
<td>4. I would not give $15 of my own money to help the environment.</td>
</tr>
<tr>
<td>True</td>
<td>Pollution</td>
<td>5. I would be willing to ride the bus to more places in order to reduce air pollution.</td>
</tr>
<tr>
<td>False</td>
<td>Recycling</td>
<td>6. I would not be willing to separate my family's trash for recycling.</td>
</tr>
<tr>
<td>True</td>
<td>Animals</td>
<td>7. I would give $15 of my own money to help protect wild animals.</td>
</tr>
<tr>
<td>True</td>
<td>Energy</td>
<td>8. To save energy, I would be willing to use dimmer light bulbs.</td>
</tr>
<tr>
<td>True</td>
<td>Water</td>
<td>9. To save water, I would be willing to turn off the water while I wash my hands.</td>
</tr>
<tr>
<td>True</td>
<td>General</td>
<td>10. I would go from house to house to pass out environmental information.</td>
</tr>
<tr>
<td>True</td>
<td>Pollution</td>
<td>11. I would be willing to write letters asking people to help reduce pollution.</td>
</tr>
<tr>
<td>True</td>
<td>Recycling</td>
<td>12. I would be willing to go from house to house asking people to recycle.</td>
</tr>
<tr>
<td>False</td>
<td>Pollution</td>
<td>13. I have not written someone about a pollution problem.</td>
</tr>
<tr>
<td>True</td>
<td>General</td>
<td>14. I have talked with my parents about how to help with environmental problems.</td>
</tr>
<tr>
<td>True</td>
<td>Water</td>
<td>15. I turn off the water in the sink while I brush my teeth to conserve water.</td>
</tr>
<tr>
<td>True</td>
<td>Energy</td>
<td>16. To save energy, I turn off lights at home when they are not in use.</td>
</tr>
<tr>
<td>True</td>
<td>Animals</td>
<td>17. I have asked my parents not to buy products made from animal fur.</td>
</tr>
<tr>
<td>True</td>
<td>Recycling</td>
<td>18. I have asked my family to recycle some of the things we use.</td>
</tr>
<tr>
<td>True</td>
<td>Pollution</td>
<td>19. I have asked others what I can do to help reduce pollution.</td>
</tr>
<tr>
<td>True</td>
<td>General</td>
<td>20. I often read stories that are mostly about the environment.</td>
</tr>
<tr>
<td>True</td>
<td>Water</td>
<td>21. I do not let a water faucet run when it is not necessary.</td>
</tr>
<tr>
<td>False</td>
<td>Energy</td>
<td>22. I leave the refrigerator door open while I decide what to get out.</td>
</tr>
<tr>
<td>True</td>
<td>Animals</td>
<td>23. I have put up a birdhouse near my home.</td>
</tr>
<tr>
<td>False</td>
<td>Recycling</td>
<td>24. I do not separate things at home for recycling.</td>
</tr>
<tr>
<td>True</td>
<td>General</td>
<td>25. I am frightened to think people don't care about the environment.</td>
</tr>
<tr>
<td>True</td>
<td>Pollution</td>
<td>26. I get angry about the damage pollution does to the environment.</td>
</tr>
<tr>
<td>True</td>
<td>Recycling</td>
<td>27. It makes me happy when people recycle used bottles, cans, and paper.</td>
</tr>
<tr>
<td>True</td>
<td>Animals</td>
<td>28. I get angry when I think about companies testing products on animals.</td>
</tr>
<tr>
<td>True</td>
<td>Energy</td>
<td>29. It makes me happy to see people trying to save energy.</td>
</tr>
<tr>
<td>False</td>
<td>Water</td>
<td>30. I am not worried about running out of water.</td>
</tr>
<tr>
<td>False</td>
<td>General</td>
<td>31. I do not worry about environmental problems.</td>
</tr>
<tr>
<td>False</td>
<td>Pollution</td>
<td>32. I am not frightened about the effects of pollution on my family.</td>
</tr>
<tr>
<td>True</td>
<td>Recycling</td>
<td>33. I get upset when I think of the things people throw away that could be recycled.</td>
</tr>
<tr>
<td>True</td>
<td>Animals</td>
<td>34. It makes me sad to see houses being built where animals used to live.</td>
</tr>
<tr>
<td>True</td>
<td>Energy</td>
<td>35. It frightens me to think how much energy is wasted.</td>
</tr>
<tr>
<td>True</td>
<td>Water</td>
<td>36. It upsets me when I see people use too much water.</td>
</tr>
</tbody>
</table>
Appendix B – CHEAKS with answers and question category

(Attitude scale #’s 1 -36, Knowledge scale #’s 37 – 66)

B Animals  37. Most elephants are killed every year to provide people with:
   A) trophies.
   B) ivory.
   C) meat.
   D) oil.
   E) skin.

A Energy  38. Burning coal for energy is a problem because it:
   A) releases carbon dioxide and other pollutants into the air.
   B) decreases needed acid rain.
   C) reduces the amount of ozone in the stratosphere.
   D) is too expensive.
   E) pollutes the water in aquifers.

B General  39. Ecology assumes that man is what part of nature?
   A) special.
   B) related to all other parts.
   C) not important.
   D) the best part.
   E) the first part.

E Water  40. Phosphates are harmful in sea water because they:
   A) cause cancer in fish.
   B) stop reproduction in fish.
   C) make fish nervous.
   D) make the water cloudy.
   E) suffocate fish by increasing algae.

B Recycling  41. Compared to other paper, recycled paper:
   A) takes more water to make.
   B) takes less energy to make.
   C) is less expensive to buy.
   D) is harder to write on.
   E) produces more pollutants.

B Pollution  42. The most pollution of our water sources is caused by:
   A) dams on rivers.
   B) chemical runoff from farms.
   C) methane gas.
   D) leaks in the sewers.
   E) human and animal wastes.

C General  43. Ecology is the study of the relationship between:
   A) different species of animals.
   B) plants and the atmosphere.
   C) organisms and their environments.
   D) man and other animals.
   E) man and the environment.

E Pollution  44. The most common poisons found in water are:
   A) arsenic, silver nitrates.
   B) hydrocarbons.
   C) carbon monoxide.
   D) sulfur, calcium.
   E) nitrates, phosphates.

D Recycling  45. Where does most of the garbage go after it is dumped from the garbage trucks?
   A) To an aquifer where it is burned.
   B) It is dumped into the ocean.
   C) It is recycled to make plastic.
   D) To a landfill where it is buried.
   E) To farmers for use as fertilizer.
Appendix B - CHEAKS with answers and question category

(Assurance scale #5 1 - 36, Knowledge scale #5 37 - 66)

A Water 46. Which is most responsible for creating acid rain?
A) sulfur dioxide.
B) carbon dioxide.
C) ozone.
D) nitrogen.
E) ultraviolet radiation.

C Animals 47. Catching tuna in the ocean:
A) is eliminating a main food source for whales.
B) protects baby sea turtles.
C) also kills many dolphins.
D) is now against the law.
E) is necessary to keep the population size down.

E Energy 48. Which is an example of a perpetual energy source?
A) nuclear.
B) oil.
C) wood.
D) uranium.
E) solar.

B General 49. Which of the following is the most dangerous to the earth's environment?
A) damming rivers.
B) overpopulation.
C) tornadoes.
D) household pets.
E) nuclear power plants.

A Pollution 50. Most of the lead in our air is caused by:
A) cars.
B) industrial plants.
C) airplanes.
D) burning refuse.
E) cigarettes

A Recycling 51. Pre-cycling means that:
A) people buy things that can be used again.
B) more people should ride bicycles.
C) small children should wear the clothes of their older brothers or sisters.
D) items should be tested before we buy them.
E) environmental changes are always taking place.

D Animals 52. Animals alive today are most likely to become extinct because:
A) natural selection kills weaker animals
B) where they live is getting too warm.
C) they are unable to reproduce because of pollution.
D) the habitat where they live is destroyed.
E) their food supply is destroyed by acid rain.

A Energy 53. Coal and petroleum are examples of:
A) fossil fuels.
B) renewable sources of energy.
C) energy sources that are plentiful.
D) alternative sources of energy.
E) recycled resources.

E General 54. Environmental problems are a threat to:
A) mostly people in small countries
B) only people in small countries
C) only wild animals and endangered species
D) mostly tropical plants and animals
E) all living things in the world.
Appendix B – CHEAKS with answers and question category

(Attitude scale #'s 1 -36, Knowledge scale #'s 37 - 66)

B Pollution 55. Which of the following doesn’t do much to reduce the pollution by automobiles:
A) properly tuned engine.
B) high octane gas
C) low lead gas.
D) smog control devices
E) propane engines

A Recycling 56. The main problem with landfills is that they:
A) take up too much space.
B) are ugly to look at and smell bad.
C) attract rats and other pests.
D) prevent farming of nearby land.
E) do not produce enough methane.

E Water 57. Building a dam on a river can be harmful because it:
A) makes the river muddy.
B) can no longer be used to make electricity.
C) increases level of pollution on the water.
D) causes the river to flood.
E) damages the river’s natural ecosystem.

D Water 58. Where is water under the ground found?
A) in landfills.
B) in ponds.
C) in low pressure areas.
D) in aquifers.
E) in rivers.

B Animals 59. Killing animals like wolves that eat others:
A) is necessary and should be done.
B) may increase the number of other animals.
C) does not affect other animals in the area.
D) may decrease the number of other animals.
E) will help protect the environment.

A Energy 60. An example of a nonrenewable resource is:
A) petroleum.
B) trees.
C) ocean water.
D) sunlight.
E) animals raised for food.

A Pollution 61. Most air pollution in our big cities comes from:
A) cars.
B) jet planes.
C) factories.
D) big trucks.
E) landfills.

A Recycling 62. An item which cannot be recycled and used again is:
A) disposable diapers.
B) newspapers.
C) aluminum cans.
D) motor oil.
E) plastic bottles.

B Water 63. What is the main problem with the use of aquifers for a water supply?
A) They recharge too quickly.
B) They are becoming used up.
C) They contain too much fresh water.
D) They contain too much salt water.
E) It is hard to get the water out.
Appendix B – CHEAKS with answers and question category

(Attitude scale #’s 1-36, Knowledge scale #’s 37-66)

D Animals 64. A species that no longer exists is:
   A) protected.
   B) endangered.
   C) abundant.
   D) extinct.
   E) wild game.

C Energy 65. Which uses the most energy in an average house in the United States?
   A) lights.
   B) TV.
   C) hot water heater.
   D) telephone.
   E) refrigerator.

B General 66. Which of the following groups is most interested in environmental issues?
   A) Boy Scouts of America.
   B) The Sierra Club.
   C) Kiwanis.
   D) 4-H Club.
   E) The American Cancer Society.
APPLY TO JOIN THE
ENVIRO-MENTALS

The Enviro-Mentals are a select group of sixth and seventh grade
students participating in the school's first field techno-science course. This
course will combine cool scientific lab work with cutting edge computer tools as
we try to help the environment.

The emphasis of the seven month course is to give students an opportunity
to become scientists participating in local water quality sampling while learning
correct scientific procedures in aquatic toxicology. Students will utilize access to
the internet to correspond with academic and governmental institutions about
their findings and conclusions.

There will be No Grades or Tests! in this course. Field
trips and monthly river samplings are planned.

The requirements for the Enviro-Mental's course are a strong interest in
science, a good recommendation from a WJ teacher, a parent’s permission and
the ability to attend the course on Thursdays from 10:50 - 11:50 during
lunchtime and tutorial (lunch will not be missed).
APPENDIX D
PUBLIC ADDRESS ANNOUNCEMENT
Announcement made over the public address system prior to the beginning of the new science club.

**New Science Enrichment Course**  
**Offered at William James**

"Beginning in September a select group of students will have the opportunity to participate in a science enrichment course led by members of the science department faculty. The course is designed as an environmental science/technology laboratory experience. Students will be involved in field work, collecting and analyzing data outdoors and uploading results online with classroom computers. Field trips are also planned.

The group will meet once a week during a one hour lunch/tutorial block so that no regular class time will be missed. It will meet all year long. The good news is that there will be no tests or homework required.

Interested students must complete an application and have a teacher’s recommendation before being considered for the course.

More details will be coming soon. Listen and watch for announcements at school."
Application for the Enviro-Mentals' techno-science field course

Complete the application below, including your parent's signature and recommending teacher's signature and submit it to Mr. Sills in room 114, or Mrs. Cagle in room 301.

Name ________________________________ Age _______ Grade _______

Homeroom teacher ______________________ Team name ______________

I am interested in participating in the Enviro-Mentals techno-field course and will be able to attend the class meetings every Thursday from October through April.

( student signature ) ( date )

The student listed above has my recommendation to participate in the Enviro-Mentals techno-field course. He/she has exhibited excellent school work habits and maintains good self discipline at all times.

( teacher signature ) ( date )

My son/daughter has my permission to participate in the Enviro-Mentals techno-field course if selected. I understand that the course takes place on Thursdays during school hours. The course meets from October until April.

( parent signature ) ( date )

Completed official permissions slips will be required before students may participate in any off-campus activity.
APPENDIX F
SUBSET OF EVALUATION INSTRUMENT
APPENDIX F - SUBSET OF CHEAKS QUESTIONS
(that closely paralleled the instruction and activities involved in the WJMS program)

Attitudes

3. To save water, I would be willing to use less water when I bathe.
9. To save water, I would be willing to turn off the water while I wash my hands.
11. I would be willing to write letters asking people to help reduce pollution.
13. I have not written someone about a pollution problem.
15. I turn off the water in the sink while I brush my teeth to conserve water.
25. I am frightened to think people don't care about the environment.
26. I get angry about the damage pollution does to the environment.
31. I do not worry about environmental problems.
32. I am not frightened about the effects of pollution on my family.
36. It upsets me when I see people use too much water.

Knowledge

39. Ecology assumes that man is what part of nature?
   A) special.
   B) related to all other parts.
   C) not important.
   D) the best part.
   E) the first part.

42. The most pollution of our water sources is caused by:
   A) dams on rivers.
   B) chemical runoff from farms.
   C) methane gas.
   D) leaks in the sewers.
   E) human and animal wastes.

54. Environmental problems are a threat to:
   A) mostly people in small countries
   B) only people in small countries
   C) only wild animals and endangered species
   D) mostly tropical plants and animals.
   E) all living things in the world.


