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Using Short-Term Environmental Education Programs To Increase Student Learning and Elicit Positive Attitude Change

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USING SHORT-TERM ENVIRONMENTAL EDUCATION PROGRAMS TO INCREASE STUDENT LEARNING AND ELICIT POSITIVE ATTITUDE CHANGE

by

Tiffany Kinder

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Watershed Science

Approved:

Nancy Mesner Major Professor	Mark Larese-Casanova Committee Member
Kimberly Lott Committee Member	Mark McLellan Vice President for Research and Dean of the School of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2012

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ABSTRACT

Using Short-Term Environmental Education Programs to Increase Student

Learning and Elicit Positive Attitude Change

by

Tiffany Kinder, Master of Science

Utah State University 2012

Major Professor: Nancy O. Mesner
Department: Watershed Sciences

Short-term environmental education programs such as water festivals and field days are a common outreach tool for watershed programs, yet little is known about their effectiveness at increasing knowledge and environmental awareness. To address this question, I conducted a formal assessment by pre- and post-testing 1400 fourth-grade students who participated in a field day at a Forest Service campground in northern Utah. During the day, each child spent approximately one hour engaged in water-related activities, with an emphasis on aquatic macroinvertebrates and water quality. My research focused on whether this single hour was sufficient to change both knowledge and interest in protecting water and aquatic organisms.

The study also compared student learning in those classes that participated only in the single event with classes that had additional water-related lessons and activities prior to and after the field day. I also examined how well variables such as teacher knowledge and attitude, socio-demographics and type of outdoor activities enjoyed by students were correlated with student knowledge and attitude.

Results demonstrated that short-term events, especially those that include additional classroom experiences, can result in knowledge gain and changes in attitudes in young children. Teacher knowledge and attitude were not correlated with student knowledge and attitude; however, school district and type of outdoor activities enjoyed by students were both good predictors of knowledge and attitude scores.

(77 pages)

Public Abstract
Using Short-Term Environmental Education Programs to Increase Student Learning and Elicit Positive Attitude Change
Tiffany Kinder

Short-term environmental education programs are used extensively by watershed groups and similar non-profit organizations to introduce elementary age students to natural resources and the environment. However, few studies have been done to determine if students are learning and becoming more aware of the environment during these educational programs. I wanted to know if these programs were worth the time, money and resources used to present them to students and what other factors may also influence student knowledge and attitude.

To address this question, I conducted a formal assessment of the Cache County Natural Resource Field Days (NR Days) program. This program provides fourth-grade students with hands-on experiences in four different environmental topics and reaches approximately 50 classrooms during a 2-week period each fall. Students and their teachers spend the day at a Forest Service campground, rotating through 4 stations covering wildlife, soils, plants and water quality. During the day each classroom spends approximately one hour engaged in water-related activities, with an emphasis on aquatic macroinvertebrates and water quality. This study focused on these water quality activities which are led by trained volunteers and staff from USU Water Quality Extension

I assigned classrooms to one of three groups:

- Group 1 participated only in NR Days,
- Group 2 participated in NR Days in conjunction with classroom lessons,
- Group 3 participated in NR Days, a second field trip, and teachers in this group received lesson plan materials and training in watershed concepts.

Group 1 was used to determine how knowledge and attitude are affected by the single short program. Groups 2 and 3 were used to determine if knowledge gain and attitude change could be enhanced by providing additional experiences for students and /or additional information to teachers.

Classroom teachers in all three groups conducted pre- and post-tests in their classrooms. Teachers also completed a questionnaire prior to attending NR Days and an evaluation after NR Days. The student test and teacher questionnaire were designed to measure knowledge and attitude.

Results show that this short term environmental education program did increase student learning and promote environmental awareness. In addition, students retained more information when the program was enhanced with extra classroom lessons or a second field experience. In this study, teacher knowledge and attitude did not seem to affect student knowledge or attitude, although it appears that attitudes and activities developed at home may have an impact. Students who enjoyed participating in activities outside, especially activities such as hiking, fishing and birdwatching generally had more pre-test knowledge and a more positive attitude regarding aquatic invertebrates and water quality.

ACKNOWLEDGMENTS

I would like to thank my advisor, Nancy Mesner, and my committee members, Mark Larese-Casanova and Kimberly Lott, for their support and guidance. I would also like to thank all the volunteers who taught at NR Field Days and Laura Hines and Eric Peterson who coordinated the teaching at NR Field Days and assisted with some classroom teaching as well. Thanks also to all the fourth grade teachers in Logan City School District and Cache County School District who were willing to test their students and allow me time in their classroom. I would also like to thank Hope Braithwaite, Hesper Kohler, Natalie Gibson and Chris Schaeler for countless hours entering data from pre- and post-tests. Anne Hunt and Brooke Robertshaw provided excellent assistance with SAS and SPSS.

And last of all, this endeavor would not have been possible without the support and encouragement from my husband, Lee, and my children, Hannah, Hunter and Sarah.

Tiffany Kinder

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BACKGROUND

Environmental education is a process of empowering people with knowledge concerning the physical, social, cultural and economic aspects of the environment and the essential links between people and natural resources. The environmental educator goes beyond factual science education to develop concern for the total ecosystem, foster awareness of environmental issues, and to shape ecologically sustainable behavior. Environmental education emphasizes critical and creative thinking skills to develop responsible and active citizens who can work individually and cooperatively to improve and protect the environment (Bogner, 1998; Bowker, 2002; Hungerford &Volk, 1990; NAAEE, 2004).

The modern environmental education movement coalesced with the first Earth Day on April 22, 1970 and continued to gain momentum with the first intergovernmental conference on environmental education, held in Tbilisi, Georgia, USSR in 1977. At this conference, goals were established that now serve as guiding principles in environmental education programs (UNESCO & UNEP, 1978). These goals are:

1. To foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas;
2. To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;
3. To create new patterns of behavior of individuals, groups, and society as a whole towards the environment.

It follows, therefore, that the ultimate goal of an environmental education program should be to foster awareness about the environment and our dependence on it and also provide knowledge and elicit a positive attitude and behavior towards the environment. The desired outcome of these programs is environmentally literate and responsible citizens who demonstrate pro-environmental behavior.

Many behavior pathway models have been developed to determine how environmental education programs can best meet the goals of environmental education, specifically how to increase knowledge and change behavior. Traditional thinking in behavior change suggests a linear model in which knowledge leads to awareness and a change in attitude which leads to action (Ramsey & Rickson, 1976). However, in the last two decades, more complex behavior change models have been developed (Hungerford & Volk, 1990). These new models suggest that knowledge is critical, but does not necessarily elicit attitude or behavior change independently. In a more comprehensive behavior change model (Hines, Hungerford & Tomera, 1987) shown in Figure 1, the intent to act is a direct antecedent to responsible environmental behavior. This intent to act is influenced by knowledge and attitude, but not in the same linear fashion as demonstrated in traditional models. In this new model, knowledge includes knowledge of ecology, knowledge of societal issues surrounding the environmental and knowledge of specific action strategies used to improve and protect the environment. Attitude, together with locus of control (or a sense of one's ability to create change) and personal responsibility, influences personality. Personality then acts in conjunction with knowledge to form the intent to act. Hines, Hungerford and Tomera, (1987) also indicated in their model that situational factors can influence environmental behavior. These factors could include social pressures, economic constraints or limited opportunities to choose actions.

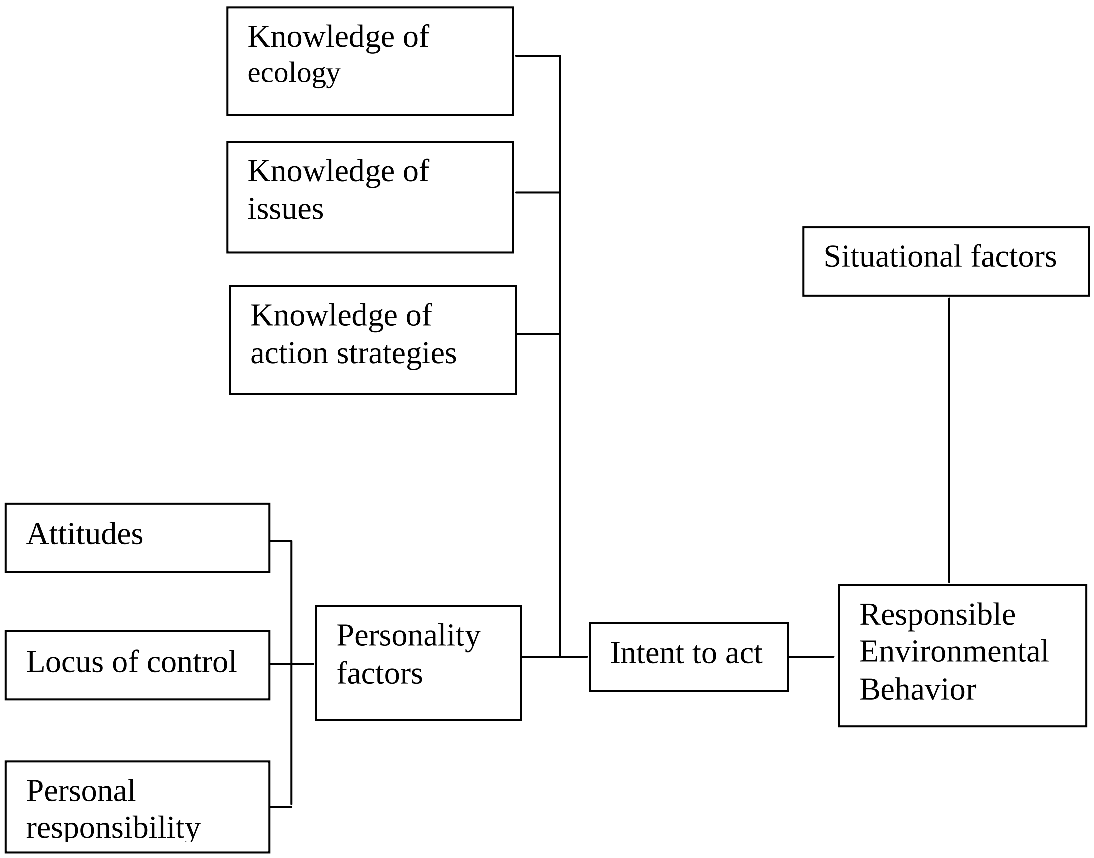

FIGURE 1. A comprehensive behavior change model (Hines, Hungerford & Tomera, 1987)

Hungerford and Volk (1990) took this model one step further and constructed an approach to implementing an environmental education program that incorporates those variables which influence behavior. Their approach describes three categories or phases of environmental education, shown in Figure 2. The three categories are 1) entry level variables, 2) ownership variables and 3) empowerment variables (Hungerford &Volk, 1990; Farmer, Knapp & Benton, 2007).

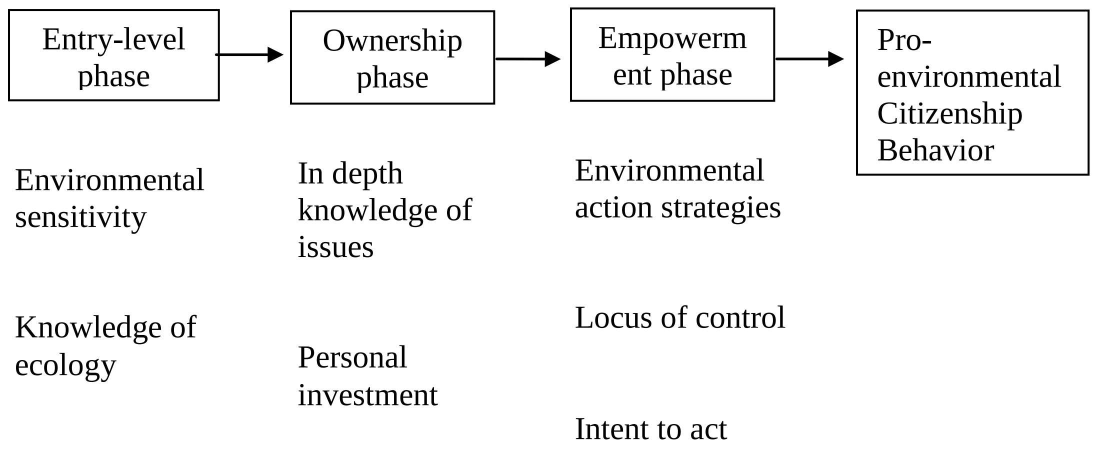

FIGURE 2. Environmental citizenship behavior flowchart (Hungerford & Volk, 1990)

In the entry-level phase, participants gain a basic knowledge of the relative scientific discipline. They also engage in activities that lead to environmental sensitivity, or an empathetic perspective toward the environment. This can be accomplished through experiences that allow a participant to interact with nature such as a nature walk or wildlife viewing and is best accomplished outdoors in a natural setting. In the ownership phase, participants gain an in-depth knowledge of the science of ecology and societal issues surrounding the environment. They begin to synthesize this knowledge with an understanding of their role in, and connection to, the environment. Environmental issues become a personal investment for them as they realize their responsibility in protecting the environment. This idea of ownership is exemplified in environmental groups who work to protect areas they care about. In the empowerment phase, participants are empowered with knowledge of environmental action strategies and skills. They learn which actions are desirable and begin to feel that their personal actions will lead to a positive change in the environment. This leads to an internal locus of control and intent to act. This is an important phase because if people do not understand what actions will protect and improve the environment, they are not likely to act accordingly (EPA, 2003).

Farmer, Knapp and Benton (2007) studied a program that targets all three phases of Hungerford and Volk's (1990) model to determine the long term impacts of knowledge and attitude change. They interviewed 15 fourth-grade students one year following participation in an ecology field trip and found that 14 of the students were able to recall ecological and environmental knowledge directly related to the field trip. Further, six students demonstrated a pro-environmental attitude in relation to content learned from the field trip. In another study, eighth-graders that received environmental action instruction as opposed to only environmental awareness instruction demonstrated more frequently a positive intent to take action against an environmental problem (Ramsey, Hungerford, & Tomera, 1981).

Integrating environmental education into the elementary school curriculum can be an effective way of meeting the goals of environmental education. During these years, children are excited about learning, are developing attitudes about the world around them (Iozzi, 1989; Jaus, 1982), and are capable of forming opinions about the environment and understanding citizen responsibilities (Bryant & Hungerford, 1977; Hacking, Barratt, & Scott, 2007).

The development of goals for environmental education and recent behavior pathway models has spawned a number of environmental education studies. From these studies several important findings emerge. First, field-based instruction is more effective than classroom based instruction at both increasing knowledge and eliciting a positive attitude (Cachelin, Paisley, & Blanchard, 2009). Furthermore, combining field based instruction with classroom instruction is more effective than either one alone (Ballantyne & Packer, 2002; Lewis, 1981). We also know that the level of environmental literacy and enthusiasm among teachers as well as teacher training can also impact environmental education programs (Swanepoel, Loubser, & Chacko, 2002). Environmental literacy can be defined by the ability to communicate about the environment and a broad knowledge and understanding of the nature and interactions between human social systems and natural systems (Disinger & Roth, 1992).

Existing research has largely supported the effectiveness of environmental education programs with duration of a week to a full year (Dillon *et al*., 2006). Little research has focused on short-term programs and therefore we do not know if we can apply the existing research findings to programs with duration of an hour up to a full day. In an informal survey of 70 non-formal educators from watershed organizations, nature centers and similar organizations in 30 states, I found that over half rely primarily on short programs to educate elementary age audiences, however only three indicated the use of a formal assessment to measure the value of these programs (Kinder, 2011). This suggests that a lot of time, money and resources go into developing and delivering short term programs without understanding fully their effectiveness.

The purpose of this study was to determine if these short term water quality educational programs, specifically those programs that are marketed to public school systems, are effective, and to what degree they increase knowledge and promote a more positive attitude towards rivers and water quality. The following five hypotheses were tested:

H1: Short-term environmental education programs do increase knowledge and promote a more positive attitude.

$H1_{0:}$ Short-term environmental education programs do not increase knowledge nor promote a more positive attitude.

H2: Short-term programs enhanced with ownership and empowerment variables lead to a higher increase in knowledge and a more positive attitude than programs without such activities.

$H2_0$: Short-term programs enhanced with ownership and empowerment variables do not lead to a higher increase in knowledge nor a more positive attitude than programs without such activities.

H3: Providing teachers with lesson plans to enhance short programs with ownership and empowerment variables and providing a second field experience leads to a higher increase in knowledge and a more positive attitude than programs without such activities.

$H3_0$: Providing teachers with lesson plans to enhance short programs with ownership and empowerment variables and providing a second field experience does not lead to a higher increase in knowledge and a more positive attitude than programs without such activities.

H4: Classroom teacher knowledge is correlated to student knowledge

$H4_0$: Classroom teacher knowledge is not correlated to student knowledge

H5: Classroom teacher attitude is correlated to student attitude.

$H5_0$: Classroom teacher attitude is not correlated to student attitude.

METHODS

Cache County Natural Resource Field Days (NR Days) is a program in northern Utah that provides fourth-grade students with hands-on activities in four different environmental topics. Approximately 60 fourth-grade classrooms (1400 students) from two area school districts participate in this 2-week program each fall. The program was initiated in 1973 by Utah State University in an effort to provide fifth-grade students with natural resource experiences (Busby, 2010). It is now a coordinated effort involving Utah State University Cache County Extension, Utah State University Water Quality Extension Program (WQE), Utah Association of Conservation Districts, Utah Division of Wildlife Resources (UDWR), US Forest Service Logan Ranger District, US Fish & Wildlife Service Bear River Migratory Bird Refuge, Cache County School District, and Logan City School District. NR Days has evolved over the years and currently serves fourth-grade students, a change that accommodates revisions in the Utah State Core Curriculum Standards (Busby, 2010). Students and their teachers spend one day at a Forest Service campground participating in four different science stations for 45 minutes each. The stations cover wildlife, soils, plants and water quality. This study focused on the water quality activities, which are led by trained volunteers and staff from WQE (Water Quality Extension, 2009).

It was my intent to assign classrooms to groups that would participate in varying levels of Hungerford and Volk’s (1990) behavior flow chart (Figure 2). Between the two participating school districts there were 23 schools with 65 fourth-grade classrooms. Two of these schools did not participate in NR Days. Of the remaining 21 schools, a total of 58 classrooms participated in the 2010 NR Days program and were included in one of three treatment groups. Table 1 summarizes these groups, the experimental treatment for each, as well as expectations. Classrooms in Group 3 were part of an ongoing pilot program with the UDWR. The remaining classrooms were divided randomly into the other two treatment groups.

TABLE 1. Study Groups with Treatment and Expectations

Group	Treatment	Expectations
Group 1 • 32 classrooms (769 students) • randomly selected	• NR Days program	Modest quantifiable knowledge gain and increase in positive attitude.
Group 2 • 19 classrooms (482 students) • randomly selected)	• NR Days program • 2 pre lesson activities taught by WQE staff • 1 post lesson/activity taught by WQE staff	Intermediate quantifiable knowledge gain and increase in positive attitude, significantly different from Group 1.
Group 3 • 7 classrooms (154 students) • self-identified	• NR Days program • Bear River Bird Refuge field trip in the spring • Teacher training on watershed concepts and water quality • Teachers have access to lesson plans and materials for use the classroom	Highest knowledge gain and increase in positive attitude, significantly different from Group 1 and Group 2.

Group 1 participated only in activities at NR Days and experienced entry-level variables as identified in the behavior flow chart (Figure 2). Station leaders taught basic ecology of aquatic macroinvertebrates and water quality. Students may have gained some environmental sensitivity by interacting with the natural habitat. The water quality activities were specifically designed to align with the Utah State Core Curriculum Standards (USOE, 2002) for fourth grade science, as well as WQE objectives (Table 2).

TABLE 2. Water Quality Activities and Alignment with Utah Core Curriculum and Water Quality Extension Objectives

WQE Objectives	Utah Core Curriculum	Water Quality Activities
NR Days		

• Learn about different types of aquatic organisms that live in Utah streams.
• Learn about life cycles of aquatic macroinvertebrates
• Learn adaptations of aquatic macroinvertebrates
• Learn how pollution affects aquatic macroinvertebrates
	• Standard 5: Students will understand the physical characteristics of Utah's wetlands, forests and deserts and identify common organisms for each environment.
	  • Objective 1: Describe the physical characteristics of Utah's wetlands, forests and deserts
	  • Objective 2: Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live
	  • Objective 3: Use a simple scheme to classify Utah plants and animals
	  • Objective 4: Observe and record the behavior of Utah animals
		• Macroinvertebrate Collection
		Students collect aquatic macroinvertebrates and explore a variety of river habitats
		• Macroinvertebrate Investigation
		Students observe aquatic macroinvertebrate behavior and use keys to identify the macroinvertebrates
		• Build A Bug
		Students learn about adaptations of aquatic macroinvertebrates

Enhancement Curriculum		
WQE Objectives	**Utah Core Curriculum**	**Water Quality Activities**

• Learn how pollution affects aquatic macroinvertebrates
• Learn about the sources or causes of pollution
• Learn how activities on the land impact the quality of our water
	• Standard 1: Students will understand that water changes state as it moves through the water cycle.
	  • Objective 2: Describe the water cycle
	• Standard 5: Student will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment
	  • Objective 2: Describe the physical characteristics of Utah's wetlands, forests, and deserts.
		• Drop in a Bucket/Incredible Journey
		Students learn about the distribution and relative amounts of water on the earth. They also learn about the water cycle and discuss specific ways to conserve water
		• Bear River Watershed
		Students learn about watersheds and practice mapping a watershed. They also learn about the history, geography and important resources in the Bear River Watershed
		• If Bugs Could Talk
		Students learn to use aquatic macroinvertebrates as an indicator of water pollution and how different land uses can contribute to water pollution.

Group 2 participated in a new curriculum developed specifically to enhance the NR Days experience (Table 2). This hands-on curriculum was designed to have a pedagogical arch, to deepen the students' understanding of water quality issues and, in conjunction with NR Days, to guide them through all three phases of the behavior flow chart (Figure 3). Two pre-activities occurred in the classroom 1-4 days prior to NR Days, one post-activity occurred in the classroom within 3 days after NR Days.

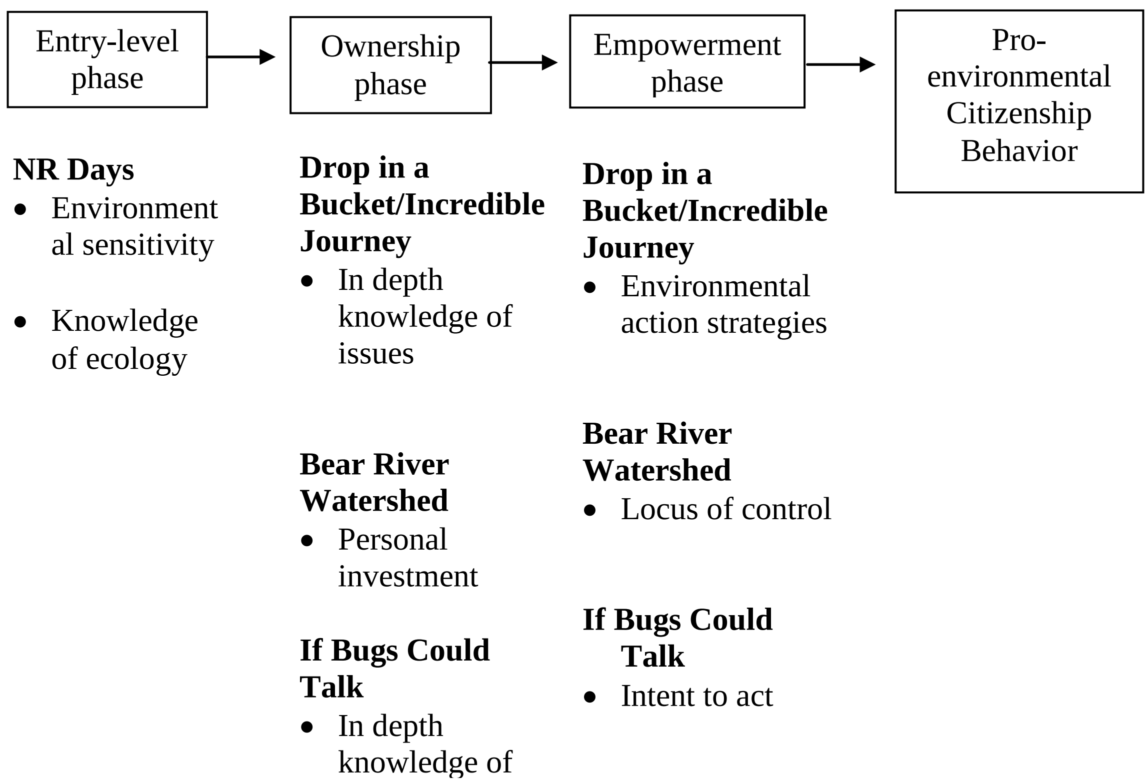

FIGURE 3. Environmental citizenship behavior flowchart with corresponding NR Days and enhancement activities

The first pre-activity was adapted from two Project WET lessons, Drop in a Bucket and Incredible Journey, (Project WET, 2008) and focused on the geographic distribution and availability of water on a global scale and the water cycle. It was designed to help students understand that water is a limited resource and that protecting water quality is important. During the activity, specific action strategies for water conservation were also discussed. By providing students with knowledge of the issues surrounding water quality and discussing specific action strategies, students experienced both the ownership and empowerment phases of the behavior flowchart.

The second pre-activity focused on two local watersheds. The purpose of this activity was to help students develop a sense of place or personal investment in their local watershed and to show that people can have a positive effect on their watershed. This activity included a watershed delineation exercise and an introduction to the history and geography of a local watershed. Several "special places" in the watershed, including one community that positively impacted the watershed (Evanston Parks and Recreation, 2009), were also discussed. Other special places included areas with recreational value or importance to wildlife such as the Bear River Migratory Bird Refuge. To prepare students for NR Days, a video was shown with underwater footage of a stonefly crawling along the stream bottom and then moving on land to emerge as an adult. By facilitating the development of a personal investment in the local watershed and an internal locus of control, this activity also guided students through the ownership and empowerment phase of the behavior flowchart (Figure 3).

The post-activity, If Bugs Could Talk, was taught within 3 days of students attending NR Days and focused on aquatic macroinvertebrates and how they can be used as an indicator of water quality. The purpose of this lesson was to give students a more in-depth knowledge of aquatic macroinvertebrates, how macroinvertebrates are linked to water quality and how water quality is linked to activities on the land. A secondary purpose was to give students a reason to protect water quality, by reinforcing the impacts of pollution on aquatic macroinvertebrates. This activity covers both the ownership and empowerment variables (Figure 3) by giving in depth knowledge of ecology and facilitating the development of an intent to act.

Group 3 consisted of 7 classrooms whose teachers self-selected to participate in a pilot program on watershed education. This pilot program expanded on the NR Days program to include a field trip in the spring to the Bear River Migratory Bird Refuge. During this field trip, students participated in activities similar to NR Days by exploring river habitats and observing aquatic invertebrates. Leaders at the bird refuge emphasized that the two field experiences are connected because the locations are connected in the watershed. NR Days was located in a Forest Service campground on a tributary of the Bear River. The later field trip occurred at the Bear River Migratory Bird Refuge, located just above the confluence of the Bear River with the Great Salt Lake. As part of the pilot program, teachers received an information packet from UDWR. This packet included the 3 lesson plans that were delivered to classrooms in Group 2. These teachers also had access to classroom activity trunks for use in their classroom. In the spring, the teachers attended in-service training with UDWR on watershed concepts and water quality. Although teachers were provided with the materials to help guide their students through all phases of the behavior flow chart (Figure 3), it was their choice to conduct the lessons.

Membership in Group 3 was limited by constraints on UDWR (Lee, 2010). The size of Group 2 was constrained by the logistics of presenting the pre- and post-activities with limited WQE staff. Nineteen classrooms were randomly selected for Group 2 from the pool of participating classrooms based on available time and resources. The remaining 32 classrooms were assigned to Group 1. Although this resulted in uneven sample sizes, at the student level I exceeded the minimum number of participants required (62) to achieve a statistical power of 0.80 (Warner, 2008).

Student Test

A 13-question test was designed for the assessment tool. The test was designed for fourth-graders with age appropriate questions and in test trials, with elementary age students, was completed in less than 10 minutes. Seven true/false, short answer and multiple-choice questions were used to measure student knowledge (Appendix A, Test 1). To measure attitude, students were asked an additional four short answer questions (Appendix A, Test 1). Three of these questions were originally used by Cachelin, Paisley, & Blanchard (2009) and modified slightly for this assessment. The test also asked students to indicate, from a list, which outdoor activities they enjoy. Assessment specialists at Utah State University and the Utah State Office of Education reviewed the test for face validity in lieu of a statistical analysis to check for validity and internal consistency.

Teachers conducted all testing of their students in the classroom. Students took the pre-test within 1 week of attending NR Days and before any classroom activities for Groups 2 and 3. Students took the 2-week post-test exactly 2 weeks after attending NR Days (and after any classroom activities for Groups 2 and 3) and the 8-month post-test 35 weeks after NR Days (and after the spring field trip for Group 3).

Each test was graded and assigned a knowledge score and an attitude score. The knowledge score was based on the student providing a correct response to the knowledge questions. The attitude score was a weighted average based on responses to the attitude statements. Students received 2 points for a positive response, 1 point for a neutral response and 0 points for a negative response.

For the outdoor activities, I categorized each activity into three groups: nature-based activities (bird/wildlife watching, hiking, fishing, lake swimming, camping); machine-based activities (riding jet skis, riding ATVs); and urban activities (pool swimming, riding my bike, playing in yard, going to a playground). These categories were based on similar categories previously published in environmental education journal articles (Ewert, Place, & Sibthorp, 2005; Gherda, 1998). The student test resulted in the following variables:

- Knowledge score – The score from the knowledge questions
- Attitude score – The score from the attitude questions
- Outdoor activity type – the type of outdoor activities indicated

I was also interested in whether socio-demographics such as income level and school district influenced student test scores. I used the percent of students on free and reduced lunches at each school for the 2010-2011 school year, as reported by each school district as a surrogate for income level. Percent of free and reduced lunches at each school ranged from 16.4 -77.4 percent.

I coded each classroom according to their school district, either Cache County School District or Logan City School District. Two classrooms belonged to a charter school and draw students from the entire county and were not included in either school district for the analysis. This resulted in 15 classrooms in Logan City School District and 41 classrooms in Cache County School District.

Teacher Test and Evaluation

A teacher questionnaire was developed to identify other factors which might affect student performance on tests (Appendix B, Teacher Questionnaire). I requested teachers fill out the questionnaire prior to their classroom attending NR Days. To measure teacher knowledge and attitude, the questionnaire included the same 13 questions as the student test. The questionnaire also included a combination of short answer and Likert scale statements to determine teacher interest in environmental education, their comfort level in teaching about watershed science and their attitudes about protecting rivers and streams. The background questions asked about their experience teaching (years teaching, number of credits, in-service/pre-service courses). I was also interested in understanding what, if any, barriers inhibit teachers in the study from conducting water science activities in their classroom or in the field. To identify these barriers, teachers indicated items from a list that would prevent them from conducting aquatic science activities in the classroom and conducting field trips to lakes and streams. Items on the list included, lack of time, lack of lesson plans, lack of funding, lack of knowledge, too messy, not safe, and lack of administrative support. The questionnaire was reviewed by education professionals for face validity.

Each teacher questionnaire was coded and the teacher assigned a knowledge score and an attitude score (calculated the same way described above for student test) based on their answers to the student test. These results, in combination with the questionnaire, resulted in the following variables, which were included in the analysis:

- Teaching years – Total number of years teaching
- NR Years – Total number of years attending NR Days
- Credits – Number of credits beyond a bachelor degree
- Pre-Service – Whether or not they took aquatic or watershed courses during their education
- In-Service – Whether or not they took in-service or professional development course related to water or watershed science
- Interest – Their interest in water or watershed science (high, medium or low)
- Likert score – Sum of responses from the three Likert scale statements.
- Knowledge score – The score from the content questions on the student test
- Attitude score – The score from the attitude questions on the student test

Teachers were asked to complete an evaluation after attending NR Days (Appendix C, Teacher Evaluation Form) asking about their perceptions of the program. The evaluation asked about NR Days being an effective use of time, if they would participate again and recommend other teachers participate as well. It also asked about NR Days overcoming barriers to teaching water science and aligning with the Utah Core Curriculum. For teachers in Group 2, the evaluation asked if they felt the classroom activities enhanced the experience at NR Days.

After all student tests, teacher questionnaires and evaluations were collected, I conducted an informal survey among the teachers. The survey was used to collect information not asked in the teacher questionnaire or evaluation form, but found to be pertinent in the final analysis. During the course of the study some teachers indicated to me that they use NR Days as an introduction to the science core and refer back to concepts learned at NR Days throughout the year. The survey asked all teachers if they do in fact refer back to NR Days throughout the year. It also asked if any teacher from Group 3 had, in fact, used the lesson plans provided them.

Statistical methods

Statistical packages SAS 9.1 and PASW 18 were used to conduct statistical tests. A probability of 5% ($p=0.05$) was considered as the statistical significance level for all statistical tests. Average classroom scores were used to conduct a classroom level analysis to determine the effect of the field day as well as the effect of each enhanced program. The data on this level were normally distributed, allowing the use of a simple paired t-test.

To compare the single field day experience with the enhanced programs, a Generalized Estimating Equation (GEE) (Liang & Zeger, 1986) was used. This model was chosen over an ANOVA as it allowed for control of within-classroom clustering and handled unequal treatment groups and missing data appropriately. This analysis was conducted on student level data and used pre-test classroom average as a surrogate for student pre-test scores.

The GEE model was also used to analyze how well the teacher variables, including knowledge and attitude, correlated with student gain in knowledge or change in attitude. Teacher factors were transformed to z scores and a factor analysis was conducted to produce latent variables to include in the GEE analysis. A factor analysis is used to measure or define an underlying characteristic, such as attitude, that cannot be measured directly. The factor analysis takes a set of variables that may relate to each other and evaluates whether they can be explained by two or three latent variables. The latent variable(s) is then used as a measure of the underlying characteristic(s) (Warner, 2008).

The GEE model was also used to determine how well the type of outdoor activity (nature-based, machine-based, or urban), percent of free/reduced lunches at the student's school (as a surrogate for income level), and school district correlated with student knowledge and attitude scores. Two different approaches were used in examining outdoor activities. First, I examined each individual activity to determine what, if any, outdoor activities were good predictors of knowledge and attitude scores on the pre-test. Second, I examined how well outdoor activity type (nature-based, machine-based and urban) predicted knowledge and attitude scores on the pre-test. Only pre-test scores were used to determine how participation in outdoor activities influences knowledge and attitude in the absence of an environmental education program. To examine how income level predicted knowledge and attitude scores, the percent free/reduced lunches at each school was used as reported by each school district. To determine if there were differences between school districts, I used school district codes determined by district membership. In the analysis of free/reduced lunches and school district, pre-test scores as well as the 2-week and 8-month post-test scores were examined.

RESULTS

H1

H1 stated that short programs do result in a significant increase in knowledge and positive attitude change among students. Group 1 participated in the short program (NR Days) only. Figure 4 shows the general shift in student knowledge scores in Group 1 from the pre-test to the 2-week and the 8-month post-tests. Mean classroom knowledge scores, shown in Table 3, increased significantly by 21 percentage points on the 2-week post-test and, although scores on the 8-month post-test remain high, there was a slight but significant decrease on the 8-month post-test (Table 3).

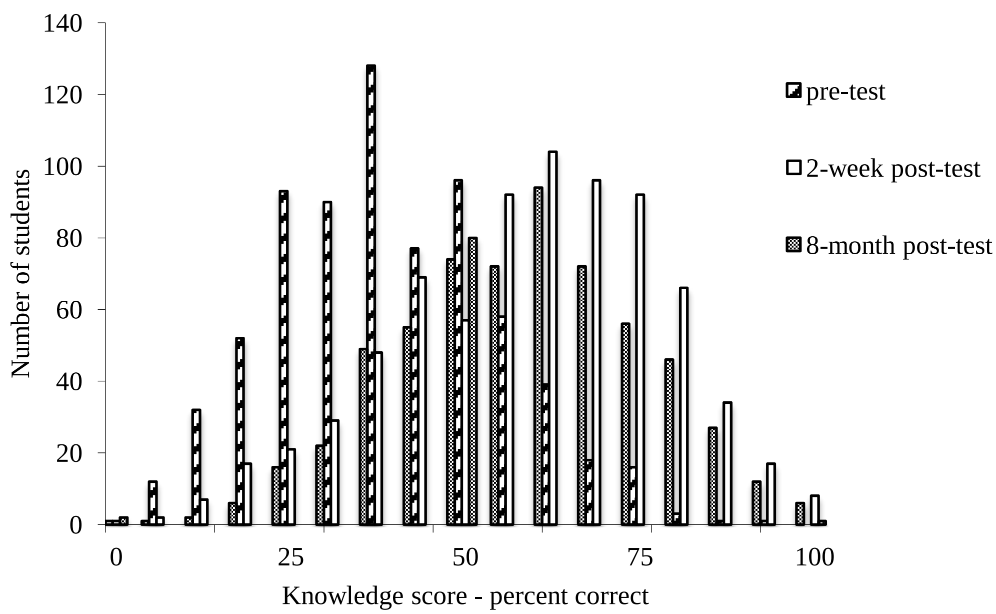

Figure 4: Distribution of student knowledge scores for Group 1

TABLE 3. Mean Classroom Knowledge Scores and Results from Simple Paired t Test for Group 1					
	n	**Mean**	**SD**	**Min**	**Max**
Pre-test	30	39.04	3.96	31.52	46.61
2-week post-test	32	59.97	5.89	48.30	74.38
8-month post-test	32	55.27	5.11	43.39	67.39

	DF	**t value**	**P**
Pre-test/2-week post-test	27	-18.12	< 0.0001***
Pre-test/8-month post-test	27	-16.01	< 0.0001***
2-week post-test/8-month post-test	29	5.31	< 0.0001***

*** Significant at the 0.0001 level

Attitude scores for Group 1 were unchanged between the pre-test and both post-tests. Figure 5 shows the distribution of student attitude scores from each test in Group 1. The mean classroom attitude score on the pre-test was 0.70, shown on Table 4, and remained at 0.70 for both the 2-week and the 8-month post-tests.

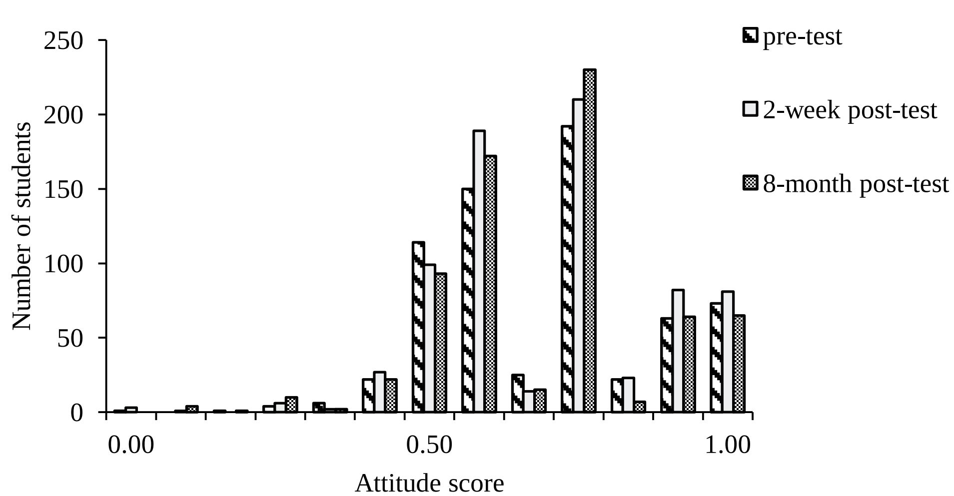

Figure 5: Distribution of student attitude scores for Group 1

TABLE 4. Mean Classroom Attitude Scores and Results from the Simple Paired T test for Group 1

	n	Mean	SD	Min	Max
Pre-test	30	0.70	0.05	0.59	0.80
2-week post-test	32	0.70	0.04	0.60	0.80
8-month post-test	34	0.70	0.04	0.63	0.78

	DF	t value	P
Pre-test/2-week post-test	27	-0.90	0.3749
Pre-test/8-month post-test	27	-0.12	0.9087
2-week post-test/8-month post-test	29	0.78	0.4407

H2

H2 stated that short-term programs enhanced with ownership and empowerment activities result in a higher increase in knowledge and positive attitude change than without such activities. Group 2 participated in the short-term program (NR Days) and also participated in classroom lessons that focused on ownership and empowerment activities (Figure 3). Figure 6 shows the distribution and general shift of student knowledge scores for Group 2 from the pre-test to the 2-week and the 8-month post-tests, which followed the same pattern as Group 1. Mean classroom knowledge scores increased by 30 percentage points from the pre-test to the 2-week post-test which represents a significant increase (Table 5). Although 8-month post-test scores remain significantly higher than the pre-test, there a significant decline from the 2-week post-test.

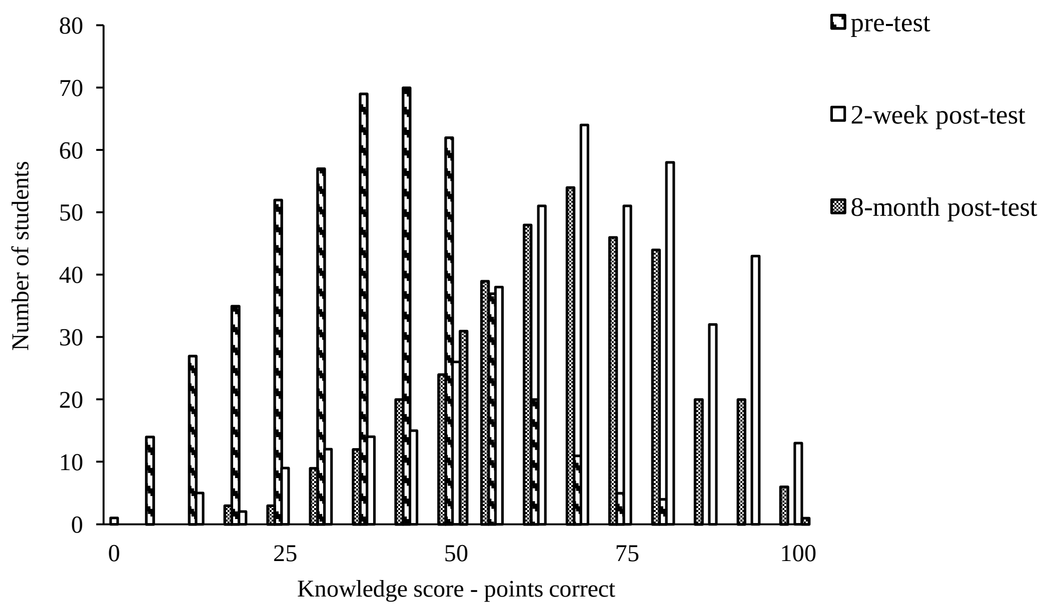

Figure 6: Distribution of student knowledge scores for Group 2

TABLE 5: Mean Classroom Knowledge Scores and Results from the Simple Paired T test for Group 2

	n	Mean	SD	Min	Max
Pre-test	19	38.18	3.82	29.50	45.07
2-week post-test	18	68.15	4.77	59.38	76.72
8-month post-test	17	62.45	4.99	50.69	68.98

	DF	T value	P
Pretest/2-week post-test	17	-29.43	< 0.0001***
Pre-test/8-month post-test	16	-18.34	< 0.0001***
2-week post-test/8-month post-test	15	6.66	<0.0001***

*** Significant at the 0.0001 level

As with Group 1, there was no obvious pattern or general shift in individual student attitude scores for Group 2 (Figure 7). Mean classroom attitude score was 0.70 (Table 6) on the pre-test and increased to 0.71 on the 2-week post-test. This was not a significant increase. Table 6 shows the t and P values from the simple paired t test conducted on attitude scores for this group. Attitude scores declined significantly on the 8-month post-test.

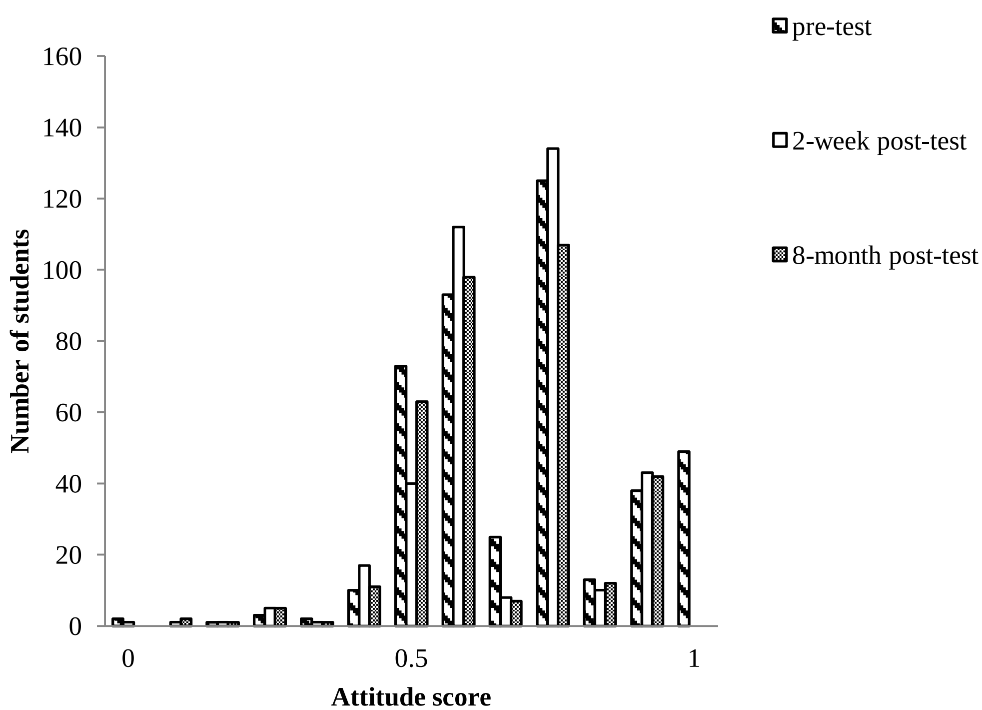

Figure 7: Distribution of student attitude scores for Group 2

TABLE 6. Mean Classroom Attitude Scores and Results from Simple Paired t Test for Group 2

	n	Mean	SD	Min	Max
Pre-test	19	0.70	0.04	0.61	0.77
2-week post-test	18	0.71	0.06	0.62	0.81
8-month post-test	17	0.68	0.03	0.60	0.73

	DF	t value	P
Pretest/2-week post-test	17	-1.36	0.1931
Pre-test/8-month post-test	16	2.13	0.0492[+]
2-week post-test/8-month post-test	15	2.45	0.0268[+]

[+]Significant at the 0.05 level

H3

H3 stated that providing teachers with lesson plans to enhance short programs and providing a second field experience leads to a higher increase in knowledge and positive attitude gain over short programs without such activities. Group 3 participated in the short program (NR Days) and a second field experience in the spring. In addition, the UDWR provided teachers in this group with the same lesson plans as those delivered in Group 2. Figure 8 shows the distribution and general shift of individual student knowledge scores for Group 3. Mean classroom knowledge scores, shown in table 7, increased significantly by 22 percentage points from the pre-test to the 2-week post-test and then declined by only two percentage points on the 8-month post-test. Unlike Group 1 and Group 2, this slight decline on the 8-month post-test was not significant.

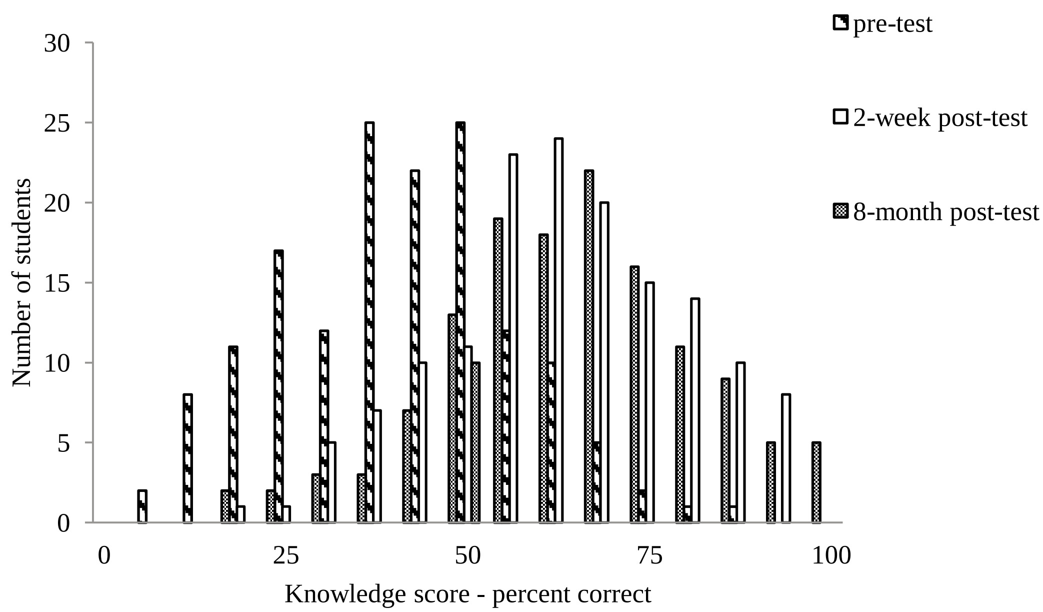

Figure 8: Distribution of student knowledge scores for Group 3

TABLE 7. Mean Classroom Knowledge Scores and Results from the Simple Paired t Test for Group 3

	n	Mean	SD	Min	Max
Pre-test	7	40.74	4.85	34.24	47.73
2-week post-test	7	63.01	7.07	55.40	77.27
8-month post-test	7	60.93	12.66	55.28	67.90

	DF	t value	P
Pre-test/2-week post-test	6	-9.49	< 0.0001***
Pre-test/8-month post-test	6	-10.88	< 0.0001***
2-week post-test/8-month post-test	6	0.90	0.4027

*** Significant at the 0.0001 level

The distribution of individual student attitude scores in this group is shown in Figure 9. Mean classroom attitude scores increased from 0.69 to 0.72 on the 2-week post-test, which approaches significance (Table 8). On the 8-month post-test attitude scores declined to 0.66; this is significantly lower than 2-week post-test scores, but not significantly different from the pre-test scores.

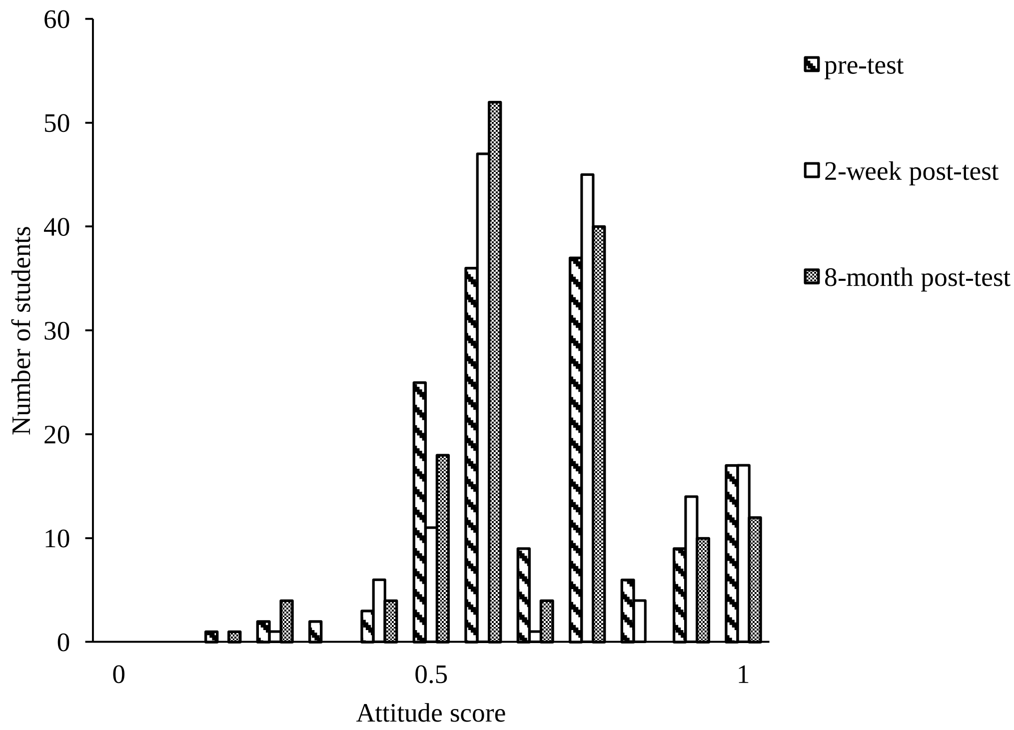

Figure 9: Distribution of student attitude scores for Group 3

TABLE 8. Mean Classroom Attitude Scores and Results from the Simple Paired t Test for Group 3

	n	Mean	SD	Min	Max
Pre-test	7	0.69	0.03	0.64	0.73
2-week post-test	7	0.72	0.04	0.66	0.79
8-month post-test	7	0.66	0.03	0.60	0.71

	DF	T value	P
Pre-test/2-week post-test	6	-2.35	0.0568
Pre-test/8-month post-test	6	0.89	0.4084
2-week post-test/8-month post-test	6	2.78	0.0319+

+ Significant at the 0.05 level

Comparing Groups

Table 9 shows the P values for the comparisons between the three groups using the GEE model. In comparing Group 1 with Group 2, group membership was a significant predictor of post-test knowledge scores on both the 2-week and the 8-month post-test with P values of < 0.0001. Students in Group 2 had a significantly higher increase in knowledge on both the 2-week and the 8-month post-test.

In comparing Group 1 with Group 3, group membership was not a significant predictor for knowledge scores on the 2-week post-test. Knowledge scores 2 weeks after NR Days increased similarly for these two groups. However, eight months later, Group 1 and Group 3 displayed a significant difference. Group 3 knowledge scores were significantly higher, compared to the pre-test, than Group 1 knowledge scores.

TABLE 9. GEE Model for Group Comparisons				
Knowledge				
	2-week post-test		8-month post-test	
	P	Difference of least square means	P	Difference of least square means
Group 1 vs. Group 2	<0.0001***	-8.72	< 0.0001***	-7.45
Group 1 vs. Group 3	0.2458	-2.87	0.0012**	-5.27
Group 2 vs. Group 3	0.0112*	5.85	0.2577	2.17
Attitude				
	2-week post-test		8-month post-test	
	P	Difference of least square means	P	Difference of least square means
Group 1 vs. Group 2	0.8610	0.002	0.1878	0.013
Group 1 vs. Group 3	0.9098	-0.002	0.2320	0.021
Group 2 vs. Group 3	0.8184	-0.440	0.6563	0.008

*Significant at the 0.01 level, ** Significant at the 0.001 level, *** Significant at the 0.0001 level

In comparing Group 2 with Group 3, group membership was a significant predictor of knowledge scores on the 2-week post-test. Students in Group 2 had a significantly higher increase in knowledge 2 weeks after NR Days. However, on the 8-month post-test, knowledge scores were similar for Group 2 and Group 3.

Group membership was not a significant predictor of attitude scores between any group for either the 2-week or the 8-month post test.

Outdoor Activities

Table 10 provides results from the GEE Model for each of the outdoor activities for the pre-test only. Students who indicated any outdoor activity had significantly higher knowledge scores than students who indicated they did not enjoy being outdoors. Students that indicated they did not enjoy being outdoors had an average pre-test knowledge score of 30.73 (SD = 14.11). Students who did not indicate that they did not enjoy being outdoors had a pre-test knowledge score of 39.80 (SD = 15.68). "I do not like to spend time outside" was the only negative predictor of knowledge scores. Of the outdoor activities, "playing in my yard" was the most highly significant positive predictor of knowledge scores.

Table 10: GEE Model for Outdoor Activities

	Knowledge		Attitude	
	P	Difference of least square means	P	Difference of least square means
Nature-based Activities				
Bird/wildlife watching	0.1611	-1.4383	0.0076*	-0.0335
Hiking	0.0437+	-1.8096	0.0034*	-0.0260
Fishing	0.4035	-0.7856	0.1634	-0.0125
Swimming in a lake	0.0200+	-2.1424	0.0107*	-0.0275
Camping	0.0270+	-1.6893	0.0370+	-0.0206
Machine-based Activities				
Riding my bicycle	0.0559+	-1.7710	0.1297	-0.0137
4-wheelers/ATVs	0.6216	-0.4430	0.5261	-0.0057
Riding jet skis/water skiing	0.6449	-0.4956	0.5170	-0.0078
Urban Activities				
Swimming in a pool	0.8788	-0.1443	0.5314	-0.0060
Playing in my yard	0.0051*	-2.8968	0.0243+	-0.0198
Playground	0.9339	-0.0754	0.0177*	-0.0243
I don't like to spend time outside	0.0005**	9.0851	0.4923	0.0201

+ significant at the .05 level, * significant at the .01 level, **significant at the .001 level

Unlike knowledge scores, attitude scores were not significantly predicted by students indicating they did not like to spend time outside. While “playing in my yard” was a significant predictor of attitude scores, the most highly significant predictor was “hiking” followed by “bird/wildlife watching.”

Table 11 shows the P values and raw score slope coefficient (*b*) estimates associated with type of outdoor activities and their correlation to knowledge and attitude scores. Participation in nature-based activities and urban activities were both significant predictors of knowledge and attitude scores on the pre-test with nature-based activities being the more highly significant. Raw score slope coefficients indicate that for each additional nature-based or urban activity marked, knowledge and attitude scores increased. The P value for nature-based was smaller than urban activities suggesting that nature-based activities have a higher significance. Figures 10 and 11 show the relationship between number of nature-based activities indicated and knowledge and attitude scores for the pre-test.

TABLE 11. GEE Model – P Values and Raw Score Slope Coefficients Associated with Type of Outdoor Activities and Knowledge and Attitude Scores

	Knowledge		Attitude	
	P	b	P	b
Nature-based	0.0013**	0.9394	0.0004**	0.0100
Machine-based	0.4211	0.7165	0.4481	0.0048
Urban activities	0.0079*	0.9044	0.0096*	0.0071

* significant at the .01 level, ** significant at the .001 level

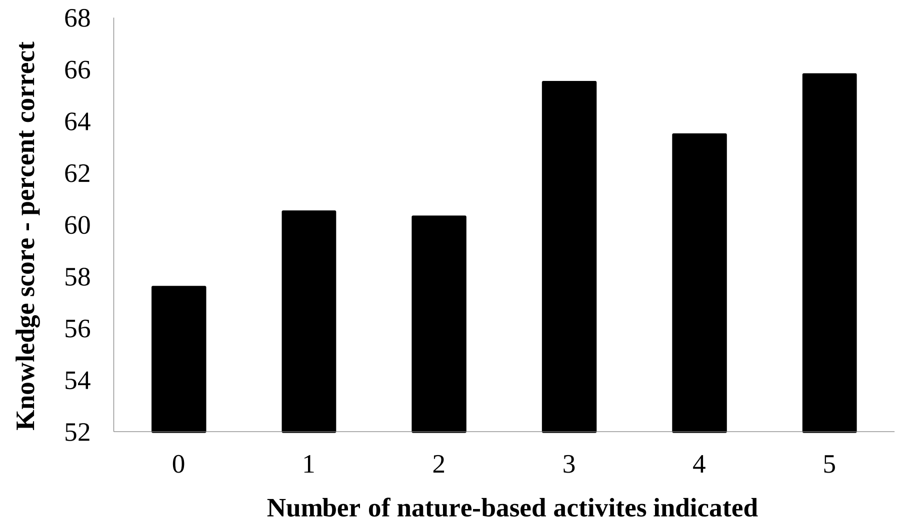

Figure 10. Relationship between number of nature-based activities indicated and knowledge scores for the pre-test

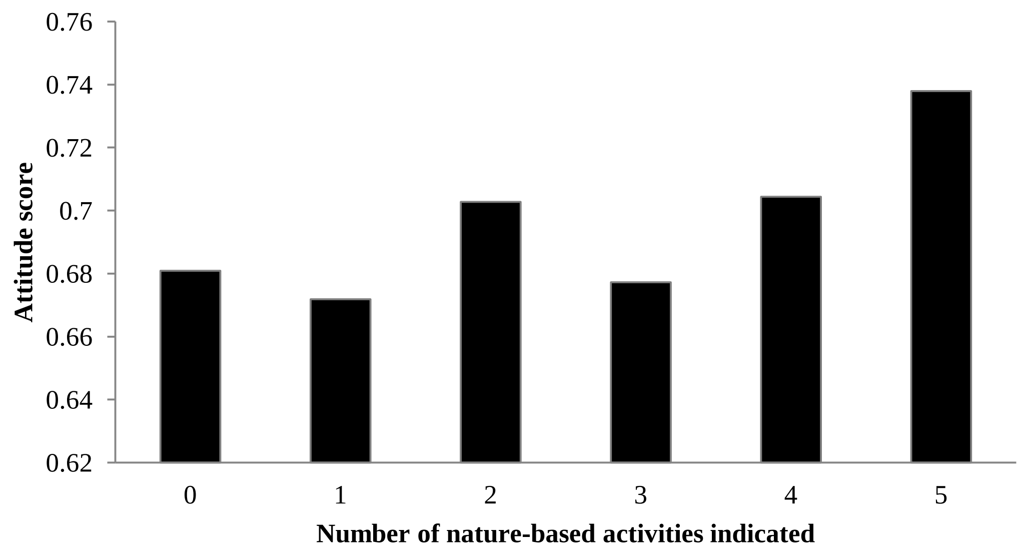

Figure 11. Relationship between number of nature-based activities indicated and attitude scores for the pre-test

Socio-Demographics

Although I considered that income level might be a significant predictor of knowledge and attitude scores, percent of free/reduced lunches (used as a surrogate for income level) was not a significant predictor of knowledge or attitude scores on either the 2-week or the 8-month post test. I could not find research that reports how income level influences environmental knowledge or attitude as a result of an environmental education program among elementary age students. However, Castelli *et al*. (2007) found that participation in free/reduced lunches was not related to overall academic achievement in the classroom among third and fifth-grade students.

School district did have a significant effect on student knowledge. Students that belonged to Cache County School District not only had higher pre-test knowledge scores, but also had a significantly higher increase in knowledge on the 2-week and the 8-month post test (Table 12). School district was not a significant predictor for attitude scores.

TABLE 12: Mean Classroom Knowledge Scores and Results from the GEE model for Rural/Urban Comparison

		N	Mean	SD	Min	Max
Logan School District						
	Pre-test	282	35.99	15.26	6.25	81.25
	2-week post	357	58.21	20.98	6.25	100
	8-month post	316	53.48	18.30	0	100
Cache County School District						
	Pre-test	999	39.75	15.96	0	87.5
	2-week post	934	64.82	18.14	0	100
	8-month post	858	59.97	16.60	11.1	100

	2 -week post-test		8-month post-test	
	P	Difference of least square means	P	Difference of least square means
Logan vs Cache	0.0096*	-5.5842	0.0091*	-5.5528

* Significant at the .01 level

Teacher Analysis

Fifty-two teachers returned completed questionnaires prior to NR Days. These teachers collectively had an average of 15 years teaching experience and an average of 10 years experience teaching fourth grade (see Table 13). They were well educated with an average of 34 credits beyond a bachelor's degree. Thirty percent had participated in pre-service courses that taught about aquatic or watershed science and 32 percent had taken in-service courses dealing with aquatic or watershed science. Fifty-nine percent indicated they have a medium interest in watershed science (not shown in table) while 20 percent indicated they have a high interest in watershed science. Eighty-nine percent indicated they enjoy teaching about science or the environment in their classrooms.

Table 13 breaks out the responses of Group 3 from Groups 1 and 2. Because teachers in Group 1 and 2 were randomly selected from participating teachers and any

TABLE 13: Teacher Variables by Group

	Average years teaching (min-max)[+]	Average years teaching fourth grade (min-max)	Average credits beyond bachelors (min-max)	Percent that have taken pre-service courses	Percent hat have taken in-service courses *	Percent that indicated a high interest in watershed science	Percent that indicated they enjoy teaching science
Group 1 and 2 N=47	14.(1-33)	9(1-30)	34 (0-140)	25%	25%	23%	90%
Group 3 N=7	25 (13-38)	22 (11-38)	34 (30-60)	67%	83%	0%	86%
Total N=54	15(1-38)	10 (1-38)	34 (0-140)	30%	32%	20%	89%

[+]Significant at the 0.05 level. * Significant at the 0.01 level differences between these two groups were due to chance and not statistically significant these groups were combined in this table. Teachers in Groups 1 and 2 had been teaching for an average of 14 years with 9 of those years teaching fourth grade. They had an average of 34 credits beyond a bachelor's degree. Only 25 percent had taken a pre-service course and 25 percent had taken an in-service course in watershed science. Twenty-three percent indicated a high interest in watershed science, yet 90 percent indicated they enjoy teaching about science or the environment.

Group 3 was significantly different from both Group 1 and 2 in years teaching and the number of in-service courses taken. They had an average of 25 years teaching experience, with 22 of those years teaching fourth grade. Sixty-seven percent had taken pre-service course in aquatic or watershed science and 83 percent had taken in-service courses in watershed science. Although no teacher in this group indicated a high interest in watershed science, all but one teacher in this group indicated they enjoy teaching about science and the environment.

The factor analysis resulted in two factors or latent variables. Table 14 shows the loading of each of the teacher variables with the resulting factors. The variables Teacher years, Teacher years 4, Years nr, pre-service, and in-service all loaded with Factor 1 which I called Teacher Experience. The variables AS (attitude score), KSW (Knowledge score), credits, and Likert score all loaded with Factor 2 which I called Teacher Knowledge and Attitude.

TABLE 14. Factor Analysis of Teacher Variables

	Factor 1 (Teacher experience)	Factor 2 (Teacher Knowledge and Attitude)
Teacher years	0.871	0.103
Teacher years 4	0.816	0.135
Years nr	0.719	0.410
Pre-service	0.631	-0.330
In-service	0.586	0.155
AS	0.065	0.683
KSW	-0.034	0.636
Credits	0.241	0.634
Likert Score	0.105	0.632

Barriers

"Lack of time" was most often indicated as a barrier to conducting water science activities in the classroom (Table 15) for all three groups. "Lack of activities" and "lack of funding" were also frequently indicated as barriers to conducting water science activities in the classroom.

All but six teachers indicated that "lack of funding" was a barrier to conducting field trips to streams or lakes. "Lack of time" was also frequently indicated as a barrier to conducting field trips. Few teachers indicated that "lack of administrative support, "not safe", and "too messy" were barriers to conducting water activities in the classroom or in the field. "Lack of streams" was also seldom indicated as a barrier to conducting field trips to streams or lakes.

TABLE 15: Teacher-Identified Barriers to Water Science Activities

What would prevent you from doing water science activities in your classroom?

	Lack of Time	Lack of Activities	Lack of Funding	Lack of Knowledge	Too messy	Not Safe	Lack of Administration support
Group 1 and 2 (N=47)	35	24	21	13	4	1	4
Group 3 (N=7)	6	1	2	2	1	0	0
Total (N=54)	41	25	23	15	5	1	4

What would prevent you from taking your class on a science field trip to a stream or

	Lack of Time	Lack of Activities	Lack of Funding	Lack of Knowledge	Too messy	Not Safe	Lack of Administration support	Lack of Streams
Group 1 and 2 (N=47)	24	9	43	8	3	4	5	5
Group 3 (N=7)	4	0	5	1	0	0	1	0
Total (N=54)	28	9	48	9	3	4	6	5

H4 and H5

H4 and H5 stated that teacher knowledge is correlated with student knowledge and teacher attitude is correlated with student attitude. This study supported the null hypothesis in both cases. Neither teacher knowledge nor teacher attitude, as measured from the questions on the student test, was correlated significantly with student knowledge or attitude. The latent variables from the factor analysis were not a significant predictor of knowledge or attitude scores on either the 2-week or the 8-month post-test.

Teacher Evaluation of NR Days

Forty-three teachers returned evaluations completed after NR Days. Over 80 percent of participating teachers felt that NR Days was an effective use of time, that it overcame barriers to teaching about water science and they will participate again next year (Table 16). The only reservation teachers had about participating in subsequent years was sufficient funds for bussing. All teachers agreed that NR Days aligned at least somewhat with the Utah State Core Curriculum. Ninety-three percent of teachers from the experiment group commented that additional activities enhanced the students' experience at NR Days. Just over half the teachers would be willing to participate in workshops training them to conduct classroom activities about water and water quality. A proportionally larger number of teachers from Group 2 and Group 3 were interested in participating in training workshops.

TABLE 16. Results from the Teacher Evaluation					
		Group 1 (n = 24)	Group 2 (n = 14)	Group 3 (n = 5)	Total
Do you feel NR Days is an effective use of time?	Yes	100%	100%	100%	100%
	No	0	0	0	0
Do you feel NR Days overcomes any barriers to teaching about water science?	Yes	92%	86%	20%	81%
	Other positive comment	8%	14%	60%	16%
	No	0	0		0
Does NR Days align with the Utah Core Curriculum?	Yes	87%	79%	100%	86%
	Mostly	13%	21%	0	14%
	No	0	0	0	0
Do you think you will participate again next year?	Yes	100	100	80%	98%
	No	0	0	0	0
Would you recommend other teachers participate?	Yes	96%	100%	100%	98%
	No	0	0	0	0
Did the additional activity enhance the experience of NR Days?	Yes	n/a	93%	40%	79%
	No		0	0	0%
Would you participate in training workshops to conduct classroom activities	Yes	42%	86%	60%	58%
	Conditionally, yes	33%	0	40%	23%
	No	21%	14%		16%

DISCUSSION

Short-term programs can meet the goals of environmental education by increasing knowledge. Referring back to the behavior flow chart (Figures 2 and 3) (Hungerford & Volk, 1990), it may be that the entry-level phase is most essential to having a successful environmental education program. A 1-hour experiential program was shown to be sufficient to significantly increase student knowledge. Students in Group 1 who only experienced NR days showed a significant increase in knowledge 2 weeks and 8 months after the event. Students in Group 1 participated only in the entry-level phase of environmental education, which includes basic ecology and environmental sensitivity, yet they gained a significant level of knowledge and retained most of that knowledge for at least eight months. However, the quality of the short-term program was an important contributor to its success. Education programs that take place in a natural setting, as opposed to a classroom setting, lead to more knowledge gain, positive attitude development and environmental sensitivity (Cachelin, Paisley, & Blanchard, 2009; Crompton & Sellar, 1981; Iozzi, 1989). Also, educational programs that use hands-on learning techniques, such as those employed at NR Days where students have the opportunity to investigate natural habitats and interact directly with aquatic invertebrates, are more effective at increasing awareness and knowledge (Ballantyne, Fien, & Packer, 2000; Paris, Yambor, & Packard, 1998;). This suggests that NR Days was successful at increasing student knowledge by providing basic knowledge, but more importantly, engaging students in hands-on activities in a natural setting.

This study also demonstrated that additional activities that enhanced the short-term NR Days with ownership and empowerment variables lead to a higher increase in knowledge. Group 2 and Group 3 experienced different approaches to enhancing a short program (additional classroom lessons compared to an additional field trip and some training and materials). Higher knowledge gain and increased positive attitude from Group 3 was expected because of the anticipated involvement of their teachers.

On the 2-week post test, Group 2 had significantly higher post-test scores than Group 1, as was anticipated, but unexpectedly also had higher scores than Group 3. Because teachers in Group 3 were provided lesson plans for their classroom use before and after NR Days, I assumed that they would be used. In fact, in interviewing these teachers after the study, I found these lessons were not used (Kinder, 2010). Therefore, prior to the 2-week post test students in Group 3 received instruction very similar to Group 1, making Group 2 the only group with additional classroom lessons. Bowker (2002) also demonstrated that linking field visits to classroom experiences not only prepared students for the experience, but also increased opportunities for learning. One teacher from Group 2 commented, during the final classroom visit after NR Days, on the difference between her students, who were more engaged at the water station, and her colleague's students (from Group 1), who were less engaged. Ballantyne and Packer, (2002) also found that students who participated in pre field trip activities were more excited for the field trip than students who did not participate in pre activities.

On the 8-month post-test Group 2 still had significantly higher knowledge scores than Group 1; however, Group 2 and Group 3 were no longer significantly different.

Because teachers in Group 3 did not deliver the enhanced curriculum, this loss of significance between Group 2 and Group 3 on the 8-month post-test is most likely a result of the second field experience. After attending the spring field trip, students from Group 3 were able to recall information learned at NR Days significantly better than Group 1 and as well as Group 2.

The apparent similarities between Group 2 and Group 3 on the 8-month post-test suggest that long-term knowledge retention can be achieved in two very different ways. It can be achieved through classroom lessons in conjunction with a field trip; it can also be achieved through a follow-up field trip. Combined classroom and field experiences have been shown to be more effective than field experiences alone (Ballantyne & Packer, 2002; Lewis, 1981); however, this study showed that multiple field experiences can be as beneficial as combining classroom and field experiences.

While it is clear that student knowledge increased as a result of NR Days, it is less clear how attitudes were affected. Attitude scores on the 2-week post-test remained significantly unchanged for all three groups (although Group 3 approached significance). However, on the 8-month post-test attitude scores showed a slight, but significant decline for both Groups 2 and 3. This suggests that NR Days did not lead to an increase in positive attitude and that enhancing NR Days with classroom lessons and additional field experiences did not impact attitudes either. This could be due to several reasons: 1) there was no change in positive attitude; 2) challenges inherent in measuring attitudes of young students; 3) insufficient test questions; 4) the method used to quantify responses was insufficient.

It is possible that we did not see a significant increase in positive attitude as a result of NR Days because there was no change. NR Days may not lead to an increase in positive attitude. Knapp and Barrie (2001), also found no change in attitude after fourth, fifth, and sixth-grade students participated in an experiential, outdoor field trip, although knowledge was increased significantly. Eagles and Demare (1999) found that after a week-long Sunship Earth program students' environmental attitudes were statistically unchanged. They suggest this was because of the moderately high level of environmental attitudes of the students prior to participation. Students who participated in NR Days did exhibit moderately positive attitudes (0.7 on a scale from 0-1 with 1 being highly positive) on the pre-test towards nature and therefore may not have exhibited a significant increase. In addition, NR Days may not be of sufficient duration to elicit a change in attitude. Bogner (1998) found that students who participated in a 5-day outdoor environmental education program exhibited a higher increase in positive attitude than did students who participated in a 1-day outdoor environmental education program.

The lack of change may also be due to challenges with measuring attitudes of young people. Attitudes in general are complex and difficult to measure (Ryan, 1991). Added to this difficulty, elementary age students, more so than older students and adults, are likely to respond to questions about their attitudes with socially desirable responses that may not necessarily reflect their own attitude (Crandall & Crandall, 1965; Jerginan & Wiersch, 1978). Therefore, students may have answered the questions based on what they thought the "right" answer was and not necessarily how they felt about rivers or streams.

A third reason for a lack of quantifiable change could be due to the type of questions asked. The questions used may not have given an accurate measure of student attitude. Students were asked to complete the following two statements "*I would visit a river or stream because…*" and "*I would not a river or stream because….*" The second statement may have forced students to think of a reason for which they would not visit a river or a stream. This may have falsely brought down the weighted averages of attitude scores.

It is also likely that the lack of a quantifiable change was due to the method used to quantify attitude responses. Responses were coded positive, neutral, or negative without regard to the level of awareness of the student or detail in the response. For example, on the pre-test 45 percent of students responded to the question, *'If you could tell a good friend one or two things about rivers or streams, what would you tell them?'* with a positive statement such as:

-I would tell them to keep them clean.
-that they are cool.
- do not litter in the water

On the 2-week post-test, in response to the same question, 51% of the students responded with a positive statement. Of these students however, 20% of the answers indicated a higher awareness and were more detailed in their responses:

-I would say try not to make rivers dirty because clean water mean more bugs
-I would tell my friend that it is not good to pollute the water. And that the little water bugs are cool.
-they have really cool bugs in them and not to litter in them
-it is fun learning about water bugs.

On the pre-test students understood and indicated that we should keep rivers clean, however on the 2-week post-test they were able to give specific reasons for keeping rivers clean and showed excitement regarding learning about rivers. These qualitatively different, positive statements from the 2-week post-test suggest that students did gain some environmental sensitivity from NR Days which may translate into a more positive attitude towards rivers and streams. A qualitative analysis, using an approach done by Cachelin, Paisley, and Blanchard (2009), of the attitude questions is currently being conducted to verify this change and determine if it is maintained in the long term.

This study did not find a significant correlation between teacher knowledge and attitude and student knowledge and attitude. This is likely due to the fact that teachers, with the possible exception of Group 3, did not actually teach or direct any of the activities or lessons. NR Days was led by WQE staff and trained volunteers and I taught the enhancement lessons for Group 2. Teachers from Group 3 may have delivered some of the enhancement curricula, but not in the same time frame or the same format as experienced in Group 2. A teacher effect was anticipated because of informal observations made during previous NR Days experiences. Some teachers were very involved and exhibited a high level of interest in aquatic science and aquatic invertebrates while other teachers were uninvolved and exhibited a low level of interest in aquatic science and aquatic invertebrates. I anticipated that the higher involvement and interest of teachers would translate to additional learning opportunities in the classroom and higher student knowledge and attitude scores.

The lack of a correlation between teacher knowledge and attitude and student knowledge and attitude does not necessarily mean that a correlation does not exist. Teacher knowledge was measured by using questions from the student test. The questions were very specific to the NR Days program and may not provide an accurate picture of teacher knowledge.

Teachers in Group 1 and Group 2 were statistically identical; however teachers in Group 3 had significantly more experience in years teaching and more experience in in-service courses. It could be argued that the more experienced teachers in Group 3 were responsible for the high level of knowledge retention on the 8-month post-test. Teachers from Group 3 did indicate that throughout the year they taught concepts from the enhanced curriculum delivered in Group 2 (Kinder, 2010). It could be that these teachers were able to influence their students and help them retain information learned at NR Days. However, Mesner and Walker (2007) showed that teachers with less experience, not more, had students with higher test score increases suggesting that new teachers were more enthusiastic and had more interest in using new curriculum. This could explain why these teachers did not use the new curriculum in the prescribed manner. Also, many of the concepts in the enhanced lessons are part of the Utah State Core Curriculum and therefore should have been taught by all teachers in the study during the course of the school year. Therefore, the higher test scores on the 8-month post-test in Group 3 was more likely a result from the second field experience and not the enhanced curriculum.

Despite the lack of correlation among teachers and their students, I did find a significant correlation between student test scores, both knowledge and attitude, and the outdoor activities indicated by students. The type of outdoor activity enjoyed by fourth-grade students is most likely a family influence, with students participating in activities promoted by their parents or other family members. This suggests that, based on the results of this study, student attitude and environmental knowledge may be influenced more by family experiences than by their classroom teachers. Childhood experiences in nature and interactions with adult family members are consistently mentioned as influential significant life experiences leading to a heightened awareness of and sensitivity to the environment in adulthood (Chawla, 1998; Chawla, 1999; Chawla & Cushing, 2007; Vadala, Bixler, & James, 2007) and can provide a context that is built upon by environmental education programs in school settings. Environmental education programs that allow students the opportunity to interact with nature first hand can provide the significant life experiences that will lead to environmental sensitivity (Bogner, 1998; Chawla & Cushing, 2007; Vadala, Bixler, & James, 2007). As stated by Kellner and Warpinski (1974), "attitudes and values take time to nurture; environmental literacy is no short course"; therefore the more experiences children have interacting with nature throughout their childhood the more likely they are to develop pro-environmental attitudes and behavior later in life. It is unknown if one single short-term program can provide enough knowledge and environmental sensitivity to elicit a change in behavior that is sustained throughout adolescence and adulthood. But we do know that a short-term program can serve as an important step in this life-long process. With children spending less and less time outdoors interacting with nature (Louv, 2005) environmental education programs in the school may serve as their only opportunity to learn about nature first-hand.

I also found a significant correlation between knowledge scores and school district membership. Although the reasons behind the correlation are unknown, there are some differences between the two school districts that may explain the correlation. Logan City School District encompasses the entirety of Logan City which has a population of 48,174 (US Census Bureau, 2010). Cache County School District includes a mix of smaller bedroom communities and farming communities that surround Logan City. The significant differences in knowledge scores between the two districts could be that many students in Cache County School District are exposed to a more rural environment than those residing in Logan City. Mesner and Walker (2007) found that rural students who participated in a water quality education program had higher pre-test knowledge than their urban and suburban counterparts; however rural students exhibited a smaller increase in knowledge as a result of the program. Mesner and Walker (2007) suggested that rural students had a higher pre-test knowledge of water quality issues because of their proximity to water resources; however, participating in the educational program eliminated any knowledge difference between urban and rural students. Cache County School District students not only had higher pre-test knowledge scores, but they also had a higher increase in post-test knowledge scores. It is possible that something besides a rural/urban dynamic influenced the difference between knowledge scores on the pre- and post-tests. The two districts also differ in relation to ethnic diversity. According to 2010 US Census data, 79.1 percent of Logan City residents indicted they were white persons not of Hispanic decent. In communities outside of Logan City, but within Cache County School District, residents who indicated they were white persons not of Hispanic decent range between 79.7 and 91.7 percent (North Logan City – 88.1%, Smithfield City - 91.7%, Hyrum – 79.7%) (US Census, 2010). The differences between school districts could be a function of the achievement gap, which is based on decades of research showing that white students consistently outperform minority students in subjects such as math and reading (Lee, 2002).

Teachers were overwhelmingly supportive of NR Days. In conversation and in the assessment filled out by teachers, many teachers expressed their appreciation of NR Days and its alignment with the core curriculum. Teachers use this field day to introduce students to the science curriculum for the year and refer back to concepts taught at NR Days throughout the school year (Kinder, 2010). The program is also seen as being effective at overcoming barriers that prevent teachers from conducting water science activities and field trips. The barriers identified by teachers in this study included lack of time, lack of activities and lack of funding. These barriers can be identified as the situational factors referenced in Hines's behavior change model (Figure 1). Almost 90 percent of teachers in the study indicated they enjoy teaching about science and the environment in the classroom, yet these barriers, or situational factors, prevent them conducting water science activities. NR Days provides an opportunity for teachers to bring water science activities into their curriculum despite the barriers.

CONCLUSION

Field day experiences that provide students with hands-on activities and opportunities to interact with and explore nature are sufficient to increase student learning. Field day experiences may also enhance environmental sensitivity as indicated by individual student responses to attitude questions. When field day experiences are enhanced with classroom lessons or with a second field experience, learning and long term knowledge retention increases significantly. School districts interested in developing an environmental education program or enhancing an existing program now have at least two approaches they could implement. A successful program could include a partnership between a school district and an environmental organization with professionals willing to conduct field trips and/or classroom lessons. Teacher training workshops provided by natural resource professionals that are specifically designed to train teachers to implement environmental education programs in the classroom and in the field are recommended. Simply providing teachers with curriculum and materials to enhance a short program is not sufficient.

Students who engage in nature-based activities are not only more knowledgeable concerning the environment, but have a more positive attitude as well. An environmental education program can promote the use of nature-based activities to indirectly enhance learning and positive attitude. This can be accomplished in multiple ways, such as through nature walks, wildlife viewing activities, citizen monitoring, or explorations (Siemer, 2001; University of Wisconsin Cooperative Extension, 2012; Water Quality

Extension, 2012). Communities can also promote nature-based activities through the use of watershed festivals that highlight nature-based recreational opportunities in the area.

This study looked at a single event and the short term (2 week) and the longer term (8-month) impact of that event. To deepen our understanding of the long-term impacts of a short-term program, a logical next step would be to conduct a longitudinal study that tracks a subset of students at least through mid-adolescence. Also, because type of outdoor activity was a predictor of knowledge and attitude scores and this suggests a potential parental influence, a similar study that includes a survey for parents would help determine the extent to which parental influence impacts student knowledge and attitude. Parents may significantly influence student knowledge and attitude, possibly contributing to cumulative effects with environmental education programs.

To improve the assessment tool and make conclusions regarding a change in attitude less difficult, future studies measuring attitudes of young people could use one-on-one interviews to assess student attitudes. This would alleviate any problems associated with not only interpreting student handwriting, but also with interpreting their responses. Such interviews have been used in similar studies looking at changes in student environmental attitudes after participating in an environmental education program (Farmer, Knapp, & Benton, 2007; Knapp & Poff, 2001). Other methods used to measure attitudes of elementary age students with some success include using simple Likert scales (Bogner & Wiseman, 1997; Johnson & Manoli, 2008; Manoli, Johnson, & Dunlap, 2007) and observational studies where the researcher requests a parent observe the behavior of their child after participating in an educational program (Ramsey, Hungerford, & Tomera, 1981).

The questions used to measure teacher knowledge focused on information specifically from the water quality station at NR Days and were the same questions used in the student test. The same questions for teachers and students were used to compare knowledge of the same subject material. However, teachers may have a good understanding and knowledge base of water quality and watersheds, without knowing specific facts taught at NR Days. In future studies questions that could measure the depth of knowledge a teacher may have regarding water quality and watersheds overall may prove more valuable.

This study shows that providing short-term, high-quality environmental education programs is an effective way to provide fourth grade students an opportunity to learn about the environment. This is an important finding and supports the use of short programs by organizations across the nation. These short programs may also provide significant life experiences and opportunities to gain environmental sensitivity that may lead to pro-environmental attitudes and behavior later in life. As children and families become less involved in nature, providing nature experiences for youth will become crucial in our efforts to meet the goals of environmental education, specifically to develop environmentally literate and responsible citizens who demonstrate pro-environmental behavior.

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APPENDICES

Appendix A. Student Test

Code_____

NR Days Worksheet

1. Which of the following animals would you expect to find living in the Logan River? (circle your answers)

fish	whale
beavers	worms
birds	snails
insects	sharks
jelly fish	

2. Circle the body part that allows this mayfly to breathe.

3. For the following two statements, circle *true* or *false* **AND** explain your answer.

a. Polluted water does not bother animals that live in the water.
True or False

Explain:

b. Just like humans, many aquatic insects live most of their lives as adults.
True or False

Explain:

4. Some aquatic insects in streams have tiny claws. What would they use them for?

5. Give one example of something you could do to help keep rivers and lakes clean and healthy.

6. How does a caddisfly (like the one in the picture) get the "house" that it lives in? (circle your answer)
a. It builds it out of materials it finds in the stream
b. If finds one left behind by other animals
c. It leaves the stream and builds it out of materials it finds on land
d. It grows it like a snail grows its shell

7. Grass clippings, dumped in a stream, will decompose (rot) in the water. How might this affect the insects that live in the water? (circle your answer)

a. They can't see as well
b. They have more food
c. They can't breathe
d. They are not affected
e. They will have nothing to eat

8. When you spend time outside what do you like to do?

_______Bird/Wildlife Watching
_______Hiking
_______Fishing
_______Riding jet skis or water skiing
_______Swimming in a lake or pond
_______Swimming in a swimming pool
_______Playing in my yard
_______Riding my bicycle
_______Riding 4-wheelers/other ATVs
_______Camping
_______Going to a playground
_______I don't like to spend time outside

9. List other things you like to do outside

10. Are you interested in learning more about keeping the water in rivers and lakes clean and healthy? (yes or no)
11. Are you interested in learning more about animals that live in rivers and streams? (yes or no)

12. If you could tell a good friend one or two things about rivers or streams, what would you tell them?

13. Please complete the following statements

a. If I look on the bottom side of a rock in a stream, I might find…

b. Being near a river or stream makes me feel…

c. I would visit a river or stream because…

d. I would not visit a river or stream because…

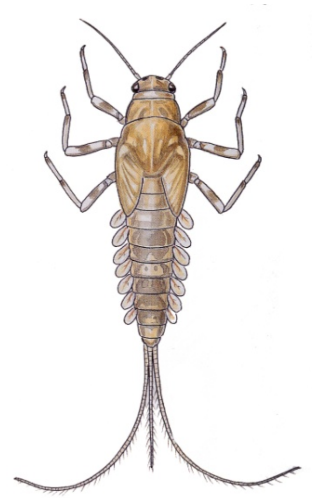
Code

NR Days Worksheet

1. Which of the following animals would you expect to find living in the Logan River? (circle your answers)

fish
whale
beavers
worms
birds
snails
insects
sharks
jelly fish

2. Use this picture of a mayfly to answer the following questions:



2a. Circle the body part that allows this mayfly to breathe.

2b. Are mayflies bothered by pollutants in the water?
(yes or no)
Please explain your answer

2c. Is the mayfly in the picture an adult mayfly or a larva (young) mayfly?

2d. Do mayflies spend most of their lives as adults or as larva (young)?

3. Some aquatic insects in streams have tiny claws. What would they use them for?

4. Give one example of something <u>you</u> could do to help keep rivers and lakes clean and healthy.

5. How does a caddisfly (like the one in the picture) get the "house" that it lives in? (circle your answer)
   a. It builds it out of materials it finds in the stream
   b. If finds one left behind by other animals
   c. It leaves the stream and builds it out of materials it finds on land
   d. It grows it like a snail grows its shell

6. Grass clippings, dumped in a stream, will decompose (rot) in the water. How might this affect the insects that live in the water? (circle your answer)
   a. They can't see as well

b. They have more food
c. They can't breathe
d. They are not affected
e. They will have nothing to eat

7. When you spend time outside what do you like to do?
_______Bird/Wildlife Watching
_______Hiking
_______Fishing
_______Riding jet skis or water skiing
_______Swimming in a lake or pond
_______Swimming in a swimming pool
_______Playing in my yard
_______Riding my bicycle
_______Riding 4-wheelers/other ATVs
_______Camping
_______Going to a playground
_______I don't like to spend time outside

8. List other things you like to do outside

9. Are you interested in learning more about keeping the water in rivers and lakes clean and healthy? (yes or no)

10. Are you interested in learning more about animals that live in rivers and streams? (yes or no)

11. If you could tell a good friend one or two things about rivers or streams, what would you tell them?

12. Please complete **ALL** the following statements

a. If I look on the bottom side of a rock in a stream, I might find…

b. Being near a river or stream makes me feel…

c. I would visit a river or stream because…

d. I would not visit a river or stream because…

Appendix B. Teacher Questionnaire

Code_______

Cache County Natural Resource Field Days
Teacher Questionnaire

1. How many years have you been teaching? ________ How many years have you been teaching 4th-6th grade? _______

2. How many years have you participated in NR Days? __________

3. How many credits do you have beyond a bachelor's degree?_______

4. Did you take science classes that taught aquatic water or watershed science during your education?_______________

5. Have you ever attended an in-service class or short-course program in water or watershed science? __________ Describe these (how many, what topics, etc.)____

6. Do you have a high, medium or low interest in water or watershed science? (please explain)

7. What would prevent you from doing water science activities in your classroom?
(circle all that apply)

a. lack of time
b. lack of good activities/lesson plans
c. lack of funding
d. lack of knowledge about water science
e. too messy
f. not safe
g. lack of administrative support
h. other (please explain)________________

8. What would prevent you from taking your class on a science field trip to a stream or lake? (circle all that apply)

a. lack of time
b. lack of good activities/lesson plans
c. lack of funding
d. lack of knowledge about water science
e. too messy
f. not safe
g. lack of administrative support
h. lack of streams or other water bodies nearby
i. other (please explain)___________

9. When you spend time outdoors what do you like to do the most?

___Bird/Wildlife Watching
___Hiking
___Riding jet skis or water skies
___Fishing
___Ski doo
___Swimming at a lake or pond
___Swimming at a swimming pool
___Reading a good book
___Riding my bicycle
___Walking or running
___Going to a city park
___Camping
___Riding 4-wheelers/other ATVs
___Other, please explain ________________
___I don't like to spend time outdoors

10. Which of the following best describes where you grew up
    a. city
    b farm
    c. rural/small town

11. For the following statements, please indicate the level at which you agree or disagree with each statement. SA = Strongly agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly disagree

		SA	A	N	D	SD
1.	I would not wade in a stream if I know insects are living in it.	1	2	3	4	5
2.	I enjoy teaching about science or the environment in my classroom	1	2	3	4	5
3.	Preventing pollution in our stream is an important issue in Cache Valley	1	2	3	4	5

12. Which of the following animals would you expect to find living in the Logan River? (circle your answers)

fish		whale
beavers	worms	
birds		snails
insects	sharks	
jelly fish		

13. Circle the body part that allows this mayfly to breathe.

14. For the following two statements, answer *true* or *false* **AND** <u>explain your answer</u>.

    a. Polluted water does not bother animals that live in the water.

    b. Just like humans, many aquatic insects live most of their lives as adults.

15. Some aquatic insects in streams have tiny claws. What would they use them for?

16. Give one example of something <u>you</u> could do to help keep rivers and lakes clean and healthy.

17. How does a caddisfly (like the one in the picture) get the "house" that it lives in? (circle your answer)
    a. It builds it out of materials it finds in the stream
    b. If finds one left behind by other animals
    c. It leaves the stream and builds it out of materials it finds on land
    d. It grows it like a snail grows its shell

18. Grass clippings, dumped in a stream, will decompose (rot) in the water. How might this affect the insects that live in the water? (circle your answer)
    a. They can't see as well
    b. They have more food
    c. They can't breathe
    d. They are not affected
    e. They will have nothing to eat

19. Are you interested in learning more about keeping the water in rivers and lakes clean and healthy? (yes or no)

20. Are you interested in learning more about animals that live in rivers and streams? (yes or no)

21. If you could tell a good friend one or two things about rivers or streams, what would you tell them?

22. Please complete the following statements

    a. If I look on the bottom side of a rock in a stream, I might find…

    b. Being near a river or stream makes me feel…

    c. I would visit a river or stream because…

    d. I would not visit a river or stream because…

Appendix C. Teacher Evaluation

NR Days Teacher Evaluation Form

Please answer the following questions, explaining your answer in a few short sentences.

1. Do you feel NR Days is an effective use of time?

2. Do you feel NR Days overcomes any barriers to teaching about water science?

3. Does NR Days align with the Utah core curriculum standards?

4. Do you think you will participate again next year?

5. Would you recommend other teachers participate who currently do not?

6. If your classroom participated in the additional activities, did you feel they enhanced the experience of NR Days? Please explain.

7. Would you participate in training workshops to conduct classroom activities about water and water quality?

8. If you have other comments about how we might improve NR Days, please share them below.