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The Impact of a Science Field Camp Experience on Students' Learning of Environmental Concepts

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Abstract

Environmental education has garnered progressively more attention in recent years as global concerns of climate issues and conservation become increasingly prevalent. Educating young students is essential to developing a generation of stewards that are knowledgeable of their environmental impact and motivated to incite positive change in their surroundings. Using a mixed-methods study, a quantitative and qualitative analysis was conducted to evaluate the Creek Critters class as part of the residential program at the Ozark Natural Science Center. Students attending the program were given pre-and post-assessments that evaluated their knowledge of the concepts of water quality and benthic macroinvertebrates discussed at the residential program. Assessments were "scored" based on their accuracy in addressing questions and demonstrating knowledge of environmental concepts. In addition, parent and teacher chaperones were interviewed to assess the perceived objectives and impacts as well as the efficacy of the residential program in educating students in matters of environmental science and conservation. Interviews were transcribed and responses were recorded. Evaluation of the post-assessments demonstrated a statistically significant decrease in overall scores; however, a significantly positive increase was recorded in the scores pertaining to water quality and benthic macroinvertebrates, the focus of the Creek Critters class. The interviews established that the chaperones' main expectation for the residential program lies in promoting stewardship rather than educating for content. Additionally, chaperones believe that the residential program is fully meeting their expectations. It is recommended that the wording of the assessments be re-evaluated to ensure clarity in prompts and that the method in which assessments are administered by the Ozark Natural Science Center be made more uniform. A larger sample size for chaperone testimony is recommended and further research is encouraged.

Table of Contents

Introduction

Background

One need not look far for some reference of the environment in the media today. Between political arguments about the need for reduced carbon emissions and scientists advocating for increased awareness of our changing climate, the need for an adequate education in environmental science is increasingly crucial. As students are encouraged to do their part to enhance their local environments and reduce their personal environmental impact, a thorough understanding on the specifics of the earth's many interconnected natural systems needs to be addressed. Successful environmental education will inform students of current and past environmental issues as well as encourage students to do their part to positively impact their local environments. The importance of environmental education can be validated through a 2003 statement from the National Science Foundation Advisory Committee for Environmental Research and Education:

> "in the coming decades, the public will more frequently be called upon to understand complex environmental issues, assess risk, evaluate proposed environmental plans and understand how individual decisions affect the environment at local and global scales."

The Ozark Natural Science Center (ONSC) in Huntsville, Arkansas aims to provide a hands-on environmental science experience for students in Northwest Arkansas and surrounding areas. The main ONSC campus sits on 489 acres of the Arkansas Natural Heritage Commission Bear Hollow Natural Area. In addition to scenic hikes and classroom time, students are taught about conservation and sustainability by discussing the process of agricultural production and monitoring their own food waste throughout their overnight stay. As stated in their mission statement, ONSC's main objectives are found on their website and stated to be: "to enhance the understanding, appreciation and stewardship of the Ozark natural environment." Although the

ONSC experience is multi-faceted, this analysis will focus on the Creek Critters class taught during the program.

The Creek Critters class is a one-hour discussion and observation time that allows for the students to study and closely observe a variety of organisms commonly found in the creeks at ONSC. The class focuses on benthic macroinvertebrates, beginning with an introduction of the term and ending with a connection to water quality parameters necessary for their survival. The class serves as a link between the water quality conditions observed and measured during the students' hikes and how these data correlate to the presence of and survival of the observed organisms. During the classroom time, students observe a variety of live "creek critters" (collected from the creek) in small dishes using identification guides placed around the classroom. After recording what organisms were present in their dishes, students related this information to the water quality data they collected earlier in the program.

The Creek Critters class was chosen as the focus of this study because of its hands-on classroom model following the experiential field model of the hike. In addition, the material taught in the classroom directly relates to the students' experience in the field, allowing for a more concentrated analysis of a specific environmental concept.

Objectives

Throughout this study, there were several objectives that guided the analysis of the field camp experience relative to the Creek Critters program and associated hikes.

Objective 1: Refine our understanding of students' prior knowledge regarding creeks and what can be found in natural creeks

Objective 2: To gauge the efficacy of a field camp learning experience in educating students about creeks and, more specifically, water quality

Objective 3: Determine what is actually being taught by the Teacher Naturalists

Objective 4: Determine the perceived effects of the field camp program through the collection of parent and teacher chaperone testimony

Justification

The purpose of this study was to assess the knowledge of students before and after their attendance in a Creek Critters program at the Ozark Natural Science Center. In addition to the quantitative analysis of the impact of the field camp on students' understanding of environmental concepts, a qualitative account of the field camp experience was also conducted. Parent and teacher chaperones were interviewed about their opinions of the field camp experience and how it could benefit the students upon their return to their classrooms.

This study sought to answer the following questions:

Research Question 1: What are the students actually learning during the field camp experience relative to water quality and indicator species?

Research Question 2: Are the children retaining the information that they learn during the field camp experience and making connections between classroom instruction and the field experience?

Research Question 3: Is the Creek Critters program effective in providing the students with an educational and hands-on experience as related to environmental science?

Literature Review

The intent of this study was to analyze the impact of a field camp experience on students' learning of environmental concepts. This section serves to present a review of the literature associated with environmental literacy, the education of environmental concepts, and hands-on experiences.

Defining Environmental Literacy

To most, literacy refers to the ability to read and write and is not easily associated with the idea of any environmental concept. However, a closer look into the definition of literacy alleviates any disjunction in defining environmental literacy, as literacy is also defined as "well educated, having or showing extensive knowledge, learning or culture" (Roth, 1992).

Notably, in 1978 at the Tbilisi Intergovernmental Conference on Environmental Education, environmental educators gathered and created useful definitions of environmental literacy as well as established an understanding of what environmental education is. Despite being a pivotal step in advocating a sense of personal environmental responsibility, the Tbilisi Declaration (1978) offers ambiguous language in terms of goals and achievements of environmental literacy (Locke, Montoya, Russo, 2013). Without a clear understanding of this vital definition, developing a successful environmental education curriculum and, perhaps more crucially, teaching exactly what environmental literacy is, is impossible.

Through the following decades, many scholars and environmental educators sought to provide a more operational definition of environmental literacy. Marcincowski (1990) adapts the Tbilisi Declaration's definition (as referenced in Roth, 1992) as such:

Environmental Literacy Involves:

A. An awareness and sensitivity towards the environment.
B. An attitude of respect for the natural environment, and of concern for the nature and magnitude of human impacts on it.
C. A knowledge and understanding of how natural systems work, as well as how social systems interface with natural systems.
D. An understanding of the various environmentally-related problems and issues (local, regional, national, international, global).
E. The skills required to analyze, synthesize, and evaluate information about environmental problems/issues using primary and secondary sources, and to evaluate a select problem/issue on the basis of evidence and personal values.

F. A sense of personal investment in, responsibility for, motivation to work individually and collectively toward the resolution of environmental problems/issues.
G. A knowledge of strategies available for use in remediating environmental problems/issues.
H. The skills required to develop, implement, and evaluate single strategies and composite plans for remediating environmental problems/issues.
I. Active involvement in all levels in working toward the resolution of environmental problems/issues.

Despite the multitude of definitions and long history of modification, environmental literacy is becoming a more commonplace theme in science classrooms.

Environmental Education

The current and operational definitions of environmental literacy are instrumental in understanding the goal of environmental education. Research has shown that effective environmental education can lead to environmentally literate citizens that are knowledgeable of current environmental issues and able to make environmentally-conscious decisions (Marcincowski, 1990; Roth, 1992). Without an environmental education, environmental literacy is impossible. An UNESCO document (1987) describes an environmental education model in which "individuals and the community gain awareness of their environment and acquire the knowledge, values, skills, experiences, and also the determination which will enable them to act- individually and collectively- to solve present and future environmental problems." This model set forth by UNSECO has proven to be a foundation for many environmental educators around the world.

Knowing the framework of an environmental education is crucial to aiding in the development of students' environmental literacy. Research has shown that simply by having an environmental education program, students are not only more likely to be environmentally literate, but also improve in other academic areas such as enhanced writing, reaching higher

reading levels, and reading a wider variety of literature as well (Cheak and Volk, 2003). Thus, environmental education programs can certainly improve environmental literacy while also accelerating students in other subject areas as well.

Leaving the Classroom and Hands-on Activities

Traditional in-class teachings offer little in the realm of hands-on experience. Investigations into the benefit of hands-on activities have shown that the experience of even one hands-on activity every week can dramatically improve scores on science-based standardized tests (Stohr-Hunt, 1996). Furthermore, in a meta-analysis including 57 studies of 13,000 students from 1,000 classrooms, students in hands-on learning programs performed 20% higher on science process tests than those in traditional classroom models (Bredderman, 1982). Compounding the researched benefits of environmental education and hands-on activities makes a compelling case for the integration of environmental literacy-driven teaching objectives in science classrooms. Furthermore, even giving children the opportunity to create visual representations of their ideas and sophisticated concepts has been proven to aid in understanding more sophisticated scientific concepts (Brooks, 2009).

Adequate environmental education goes beyond in-class teachings and is aided "by means of a combination of first-hand experience, participatory interaction, adequate preparation, and subsequent reinforcement" (Bogner, 1998). Traditional classroom settings may offer some form of hands-on learning but ultimately lack the cornerstones of an immersive field camp-style environmental education. Athman and Monroe (2001) contend that "content is more effectively conveyed when embedded in a local context, giving learners a chance to explore and experience what's around them." Presenting students with the opportunity to witness and experience their

natural environments first-hand is a unique and beneficial component of outdoor environmental education.

A step beyond leaving the classroom in isolated increments to teach students about the environment involves residential environmental education programs. Stern, Powell, and Ardoin (2008) define residential environmental programs as "programs that offer opportunities for students to explore the environment firsthand, experience adventure-based challenges, and develop stewardship skills in active outdoor settings." Research into the benefits leading to improved environmental literacy from these residential programs has shown that students demonstrate a more positive attitude toward wildlife than was demonstrated after an in-class program (Easler and Pease, 1999). Giving students the opportunity to immerse themselves in the natural world around them is vital to developing environmentally literate citizens.

Summary

The literature reviewed in this section serves as the foundation for this study. The definition of environmental literacy is well refined and carrying more influence among educators as an increasing number of schools have developed programs for integrating environmental concepts into traditional curriculum. Research has shown the effectiveness of environmental education programs throughout the past several decades by means of improved test scores, positive attitudes towards wildlife, and increased environmental literacy. This study serves to build upon past research by assessing the impact of a highly interactive and hands-on science field camp on students' learning of environmental concepts. Additionally, this study qualitatively evaluates testimony from parents and teachers in an effort to assess the attitudes and perceived value of the science field camp experience from key stakeholders.

Materials and Methods

Participants

In total, 106 male and 111 female student's assessments were used in the analysis. Thirteen schools were part of the analysis. Two of the schools were private schools and 11 were public schools.

Quantitative Analysis

Upon arriving at the Ozark Natural Science Center (ONSC), students were divided into four groups with approximately 10 students per group. The students were given backpacks equipped with safety gear, water bottles, and a field journal used with any activities (that the Teacher Naturalists, hired by the ONSC to guide and educate students throughout their stay,) scheduled. Prior to leaving for a day hike at the start of the field camp experience, students were given a "pre-assessment". This short assessment asked the students to draw and describe what they might find in a creek as well as stating if they believe organisms living in a creek could be indicative of water quality. The students were given approximately 10 minutes to complete the assessment and were told that the assessment was not graded for credit. The students then left for a three-hour hike through one of six different hiking trails through the ONSC property. Students were accompanied by a Teacher Naturalist as well as at least two parent or teacher chaperones. The hikes consisted of exploring the ONSC property while integrating learning experiences, led by the Teacher Naturalists. Although there were six different hiking paths that the Teacher Naturalists may have led the students on, all paths allowed for the same curriculum to be taught by the Teacher Naturalists. Students were expected to use their field journals to follow along with the Teacher Naturalists in field experiments and identification of flora and fauna. The field

journals included topics such as old growth forests, scat identification, water quality testing, flora and fauna identification, and fossil identification. The researcher attended three of the hikes in order to obtain a comprehensive view of the curriculum taught during the hikes. After the three-hour hike, students returned to the main ONSC campus where they ate dinner and prepared for the nighttime activities.

While still divided into groups, students were taken to a classroom for their "Creek Critters" class. This class consisted of a Teacher Naturalist discussing the creeks that students visited earlier during their hikes. The discussion focused primarily on benthic macroinvertebrates as water quality indicators. Students were told where in the creeks these organisms are found and how to distinguish between vertebrates and invertebrates. The students then were given the opportunity to observe benthic macroinvertebrates that were collected from the creek by Teacher Naturalists and brought into the classroom for direct observation. The students were given several dishes in which they could separate the organisms and identify them according to the identification keys provided in their field journals. Each Creek Critters class was one hour long. The Creek Critters classes were recorded, transcribed and analyzed for content by the researcher.

After the completion of the Creek Critters class, students were then given a "post-assessment". The post-assessment was similar in nature to the pre-assessment, asking the students to draw and describe what they found in the creek as well as prompting the students to explain how polluted water might affect which organisms are found in the creek in a short-answer section. Students were given approximately 10 minutes to complete the post-assessment. Post-assessments were administered four to twelve hours after the hike and either immediately or twelve hours after Creek Critters Class. Timing of the post-assessments was based on ONSC scheduling and not research driven.

The post-assessments were then collected and matched with each corresponding student's pre-assessment. The assessments were analyzed in terms of their accuracy and mention of certain organisms that were found in and around creeks. Students were given a score of one for each category they correctly identified, demonstrated knowledge of, or drew any of the following categories: fish, water quality, frogs, insects, rocks, benthic macroinvertebrates, tadpoles, plants, and animals. Additionally, students received a score of one for accurately drawing a stream or demonstrating a knowledge of pollution's effect on water quality. Incorrect answers were given a score of zero. In total, 217 pre- and post-assessments were used. The pre- and post-assessments were instrumental in determining the efficacy of the field camp experience from the standpoint of the researcher.

Qualitative Analysis

Parent chaperones and teacher chaperones were interviewed separately in approximately 20-minute-long, semi-structured, focus-group interviews. Parents were asked about their attitudes towards the ONSC camp as it relates to their child's overall well-being and satisfaction during their stay and their beliefs regarding the efficacy of the program in teaching their children about vital environmental concepts. Teacher chaperones were interviewed and asked about their thoughts on how the ONSC field camp experience supplemented classroom instruction. The interviews were then transcribed and grouped into thematic responses. Five parents and nine teachers were interviewed throughout the focus groups used in this analysis. These interviews aided in providing a qualitative analysis of the field camp experience at ONSC from the unique perspective of key stakeholders, parents and teachers.

Calculations and Statistics

A dependent, two-tailed T-test was used to determine the difference in scores of the pre- and post-assessments for the subjects discussed in class (i.e., fish, water quality, frogs, insects, rocks, benthic macroinvertebrates, tadpoles, plants, animals, features of a stream drawing, and effects and presence of pollution). Significance was determined at $\alpha=0.05$.

Results

Data Analysis

Research Question 1: What are the students actually learning during the field camp experience relative to water quality and indicator species?

Through observation of the hikes and Creek Critters classes and analysis of parent and teacher testimony, the researcher was able to address the first research question.

Despite all hiking paths allowing for the same topics to be covered, only a maximum of three to four of the topics were covered during one hike. However, during every hike students were required to conduct water quality testing. Water quality testing included testing water samples collected from water bodies found along the hiking paths for pH levels, nitrates, phosphates, and dissolved oxygen. Teacher Naturalists discussed the significance of these values in relation to overall water quality and aquatic organisms presence. Topics covered during the three-hour hike were left to the discretion of individual Teacher Naturalists. Teacher Naturalists were also able to integrate activities that were not listed in the field journal.

Research Question 2: Are the children retaining the information that they learn during the field camp experience and making connections between classroom instruction and the field experience?

Data collected from the assessments and interviews were evaluated to address the second research question. Data are reported in the form of descriptive statistics as summarized in Tables 1 and 2. Samples of typical pre-and post-assessment responses can be found in the appendix.

Assessment responses ranged widely in terms of accuracy and detail. As seen in the assessment samples in Figures 2-B and 3-B, some students were able to make connections between the data collected in the water quality testing conducted during the hike and the information presented in the Creek Critters class. Several responses cited specific organisms and demonstrated a clear understanding of water quality's effect on organisms found in the creek. Evaluating the students pre- and post-assessments in overall score in the categories of fish, water quality, frogs, insects, rocks, benthic macroinvertebrates, tadpoles, plants, animals, features of a stream drawing, and pollution showed that the post-assessments were statistically significantly lower. This finding demonstrates that students identified fewer of the criteria previously listed that were considered pertinent in the understanding of the Creek Critters content. (Figure 1). However, when the assessments were analyzed per individual category, the post-assessments showed a positive statistical significance in the water quality, insect, benthic macroinvertebrate, and pollution categories. The most significant positive differences were seen in the benthic macroinvertebrate and water quality categories. Two categories, rocks and tadpoles, were not statistically significantly different.

The two categories showing the most statistical significance in score adjustment were benthic macroinvertebrates and water quality, which served as the foundations for the Creek Critters Class. The remaining categories of fish, frogs, insects, rocks, tadpoles, plants, and animals were topics discussed during the students' hike prior to the Creek Critters Class. The contrast between the improved scores in the benthic macroinvertebrates and water quality

categories suggest that the information covered during the hike which was then reinforced in the Creek Critters class was retained to a greater extent than other topics discussed only during the hike.

Research Question 3: Is the field camp experience effective in providing the students with an educational and hands-on experience as related to environmental science from the standpoint of key stakeholders?

When asked about evidence of activities that drove critical thinking and encouraged problem-solving, four of the five parents responded with "Teacher Naturalist involvement" as being the most prominent piece of evidence. In response to the same question, six of the nine teacher respondents answered with "hands-on activities" as being the most compelling piece of evidence. Responses from all parents and teachers were overwhelmingly positive in regards to instruction implemented during the ONSC program.

During the interview, parents and teachers were asked about their perceptions regarding the curriculum at ONSC. When parents were asked "With respect to content, what do you want your students to get out of the experience?", only one of the five parents responded that they would like their child to get new information out of the experience. Three parents responded that they would like their child to have more respect for and accountability with the environment. The remaining parent did not have any expectation regarding content at the ONSC program. One parent responded, "I want them to learn something they didn't know before, like to be respectful of nature and to enjoy what we have". When parents were asked "What do you think ONSC is teaching your child?", two of the five parents responded with "science concepts". When teachers were asked "What do you think ONSC is teaching your students?", seven of the nine teachers

responded with “stewardship” and the remaining two teachers responded with either “career opportunities” or “love of science”.

Both parents and teachers were asked to describe what they perceived to be the objectives of the ONSC program. Three of the five parents responded that they believed the main objective of the program was to create an experience that built on classroom learning. The remaining two parents responded that the main objective was for the students to develop a sense of environmental awareness. One teacher responded, “The objective is to make the kids more aware of the environment. It’s a valuable resource and they need to take care of it”. When asked “To what extent do you believe that the objectives are being met?”, all five parents responded “fully”. Teacher responses of “perspective to the environment”, “conservation”, and “scientific knowledge” were all equally represented amongst recorded responses regarding perceived objectives. Similar to parent responses, eight of the nine teachers interviewed believed that what they perceive to be the main objectives of the ONSC program were being met fully. From the analyzed testimonies, it can be concluded that the general responses are positive and that respondents believe the program is effective in providing students with an educational and hands-on experience related to environmental science.

Discussion

Although this study marks the first quantitative and qualitative analysis of the ONSC program, impacts of similar field camp experiences are well researched. Easler and Pease (1999) concluded that a residential learning experience can have a notable impact on students’ learning that extends beyond traditional classroom instruction. The parents and teachers interviewed for this analysis reflected the previous findings. Both parents and teachers unanimously offered positive remarks regarding the ONSC program and its impact on students’ understanding of their

influence on the environment. Few respondents expressed an expectation that review or introduction of content relating to topics covered in a traditional classroom setting was to be the main objective of the ONSC program. All respondents emphasized the affective impact of the ONSC program on the students' understanding of environmental concepts.

From the responses collected in the interviews, it is shown that the most prevalent impact of the ONSC program is perceived to be the education of themes such as conservation and stewardship. As seen in the data analysis of Research Question 1, both parents and teachers believe that the main objectives of the ONSC program revolve around the idea of stewardship, leaving the expectation of educating for content as a secondary benefit.

While instilling a sense of purpose and stewardship is essential in raising a generation of environmentally-conscious individuals, the opportunities that the residential learning experience afford in terms of educating for content cannot be forgotten. Athman and Monroe (2001) emphasized the unique qualities of such an experience, illustrating that educating for content can be more successful when done in a setting that is outside of the classroom and pertinent to the subject being taught. Placing the content-based objective at the forefront of the ONSC program while maintaining the expectation of stewardship is essential to maximizing the value of the unique residential learning experience.

Recommendations

Several recommendations can be made for future researchers. Foremost, although a sample size of 217 was shown to be sufficient for the quantitative analysis of assessment scores, a larger sample size of parents and teachers for interviewing purposes is recommended. Increasing the sample size of respondents would ensure representative data from a larger demographic. In addition, increasing the sample size of respondents would account for the

interviews that included a single parent or teacher that dominated responses. Although the fourteen respondents offered an enlightening insight into the perceived impact of the ONSC program, a larger sample size is recommended for future researchers.

There were several notable issues that were encountered while compiling data from the pre-and post-assessments. First, a large portion of students either left a question unanswered or contributed a response that was not pertinent to the research. These answers were accounted for and documented, labeled as "not pertinent" in the scoring sheet. Including a multiple-choice component in future research may eliminate or restrict such answers so as to maximize the value of the responses given in the period of time allotted for the pre-and post-assessments. In addition, a notable portion of the students were perceived to have misunderstood the question asking "What do you think creek critters can tell you about the quality of the water?" on the pre-and post-assessments. It is recommended that future researchers revise the assessments to eliminate any ambiguous language that might be interpreted differently than intended. The researcher recommends that the pre-and post-assessments be re-evaluated to ensure that responses are pertinent and questions are easily understood.

Lastly, the post-assessments were administered either immediately after the Creek Critters Class or the morning following the first night of the residential program, approximately twelve hours after the Creek Critters Class. To ensure equivalence amongst students' responses, it is recommended that all students be given the post-assessments in the morning following the first night of the residential program. This method allows for approximately twelve hours between the night-time Creek Critters Class and the post-assessment. Uniformity in how the assessments are administered is essential to collecting accurate responses that are representative of the students' understanding of the environmental concepts included in the ONSC curriculum.

Conclusions

Few parents or teachers expect the ONSC program to focus on the scientific content related to environmental concepts. Even so, parents and teachers feel that ONSC is fulfilling their perceived goals of instilling a sense of responsibility and stewardship amongst students. Students demonstrated a retention of knowledge from the Creek Critters Class, particularly in the topics of water quality and benthic macroinvertebrates. However, post-assessment scores were lower overall, indicating a lack of retention in topics discussed throughout the hike, excluding the topics of water quality and benthic macroinvertebrates discussed while at the creek. Topics discussed during the hike that were then reinforced in the Creek Critters class showed the most improvement in test scores, suggesting that supplementing the field camp with classroom instruction may be necessary to educate for content at the ONSC program. Aggregating data from the assessments and testimonies indicate that the ONSC program offers a predominantly affective experience that provides a unique opportunity that allows students to experience the outdoors first-hand with their peers.

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Tables and Figures

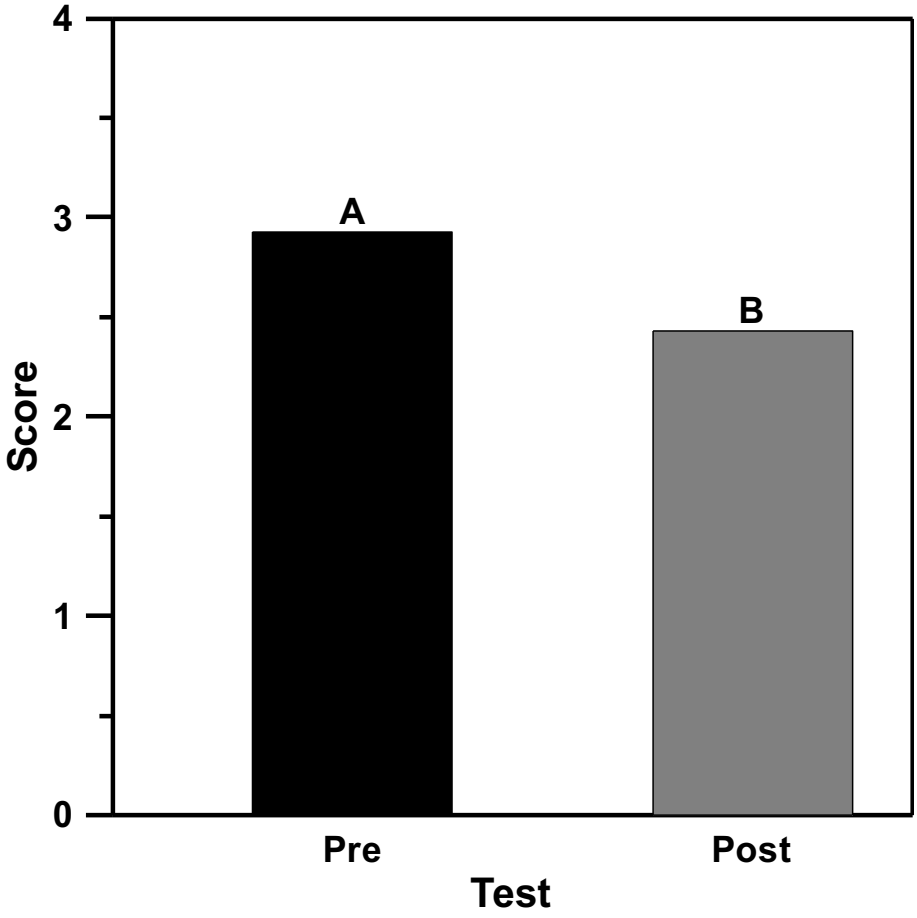


Figure 1: Overall test scores decreased significantly from the pre-assessments (column A) to the post-assessments (column B). Bars with different letters are significantly different at α=0.05.

Name [redacted] Pre-assessment

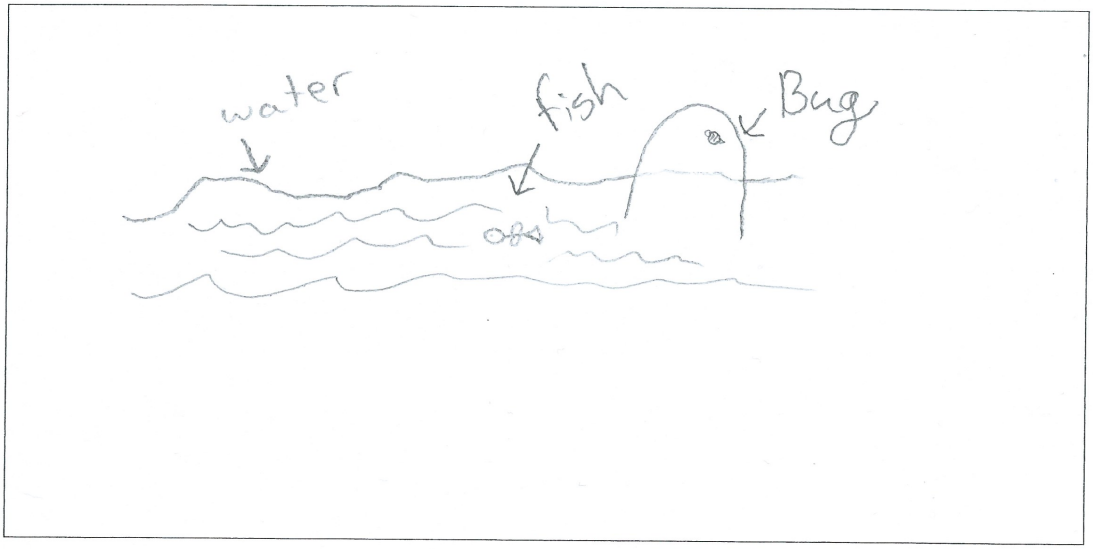
What's in the Water?

150

Imagine that you are looking down into a creek at ONSC. What would you expect to see? Explain your thinking.

I think there is going to be fish, water bugs, water. I say that because that is what you see at a creek.

In the box below, draw what you predict you will see in the creek. Label the items in your drawing.



Do you think that the organisms living in the creek can tell you anything about the quality of the water in the creek? Yes ✓ No ____ Explain your answer below.

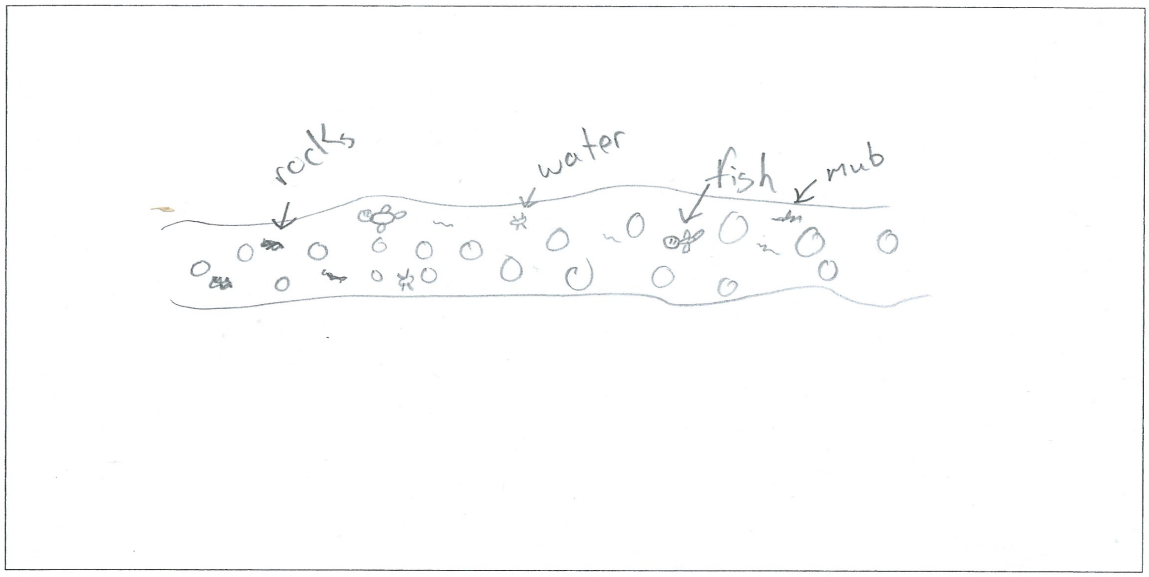
Yes! All that stuff is the world, the wild, the outside.

Figure 2-A: A sample pre-assessment as part of a paired assessment that did not change in score

Name [redacted] Post-assessment

What's in the Water? 150

1. In the box below, draw what you saw in the creek at ONSC. Label things in your drawing.



What did you actually observe in the creek? Did anything surprise you? Explain your answer.

That the water was actually clear and it had a little mud.

Do you think that the organisms living in the creek can tell you anything about the quality of the water in the creek? Yes ✓ No ____

What did you learn about the connection between the creek critters and water quality? Explain.

That the creek critters live in the water and the water quality is good.

Figure 2-B: A sample post-assessment part of a paired assessment (Figure 2-A) demonstrating a score that did not change from pre-to post-assessment

Name [redacted] Pre-assessment

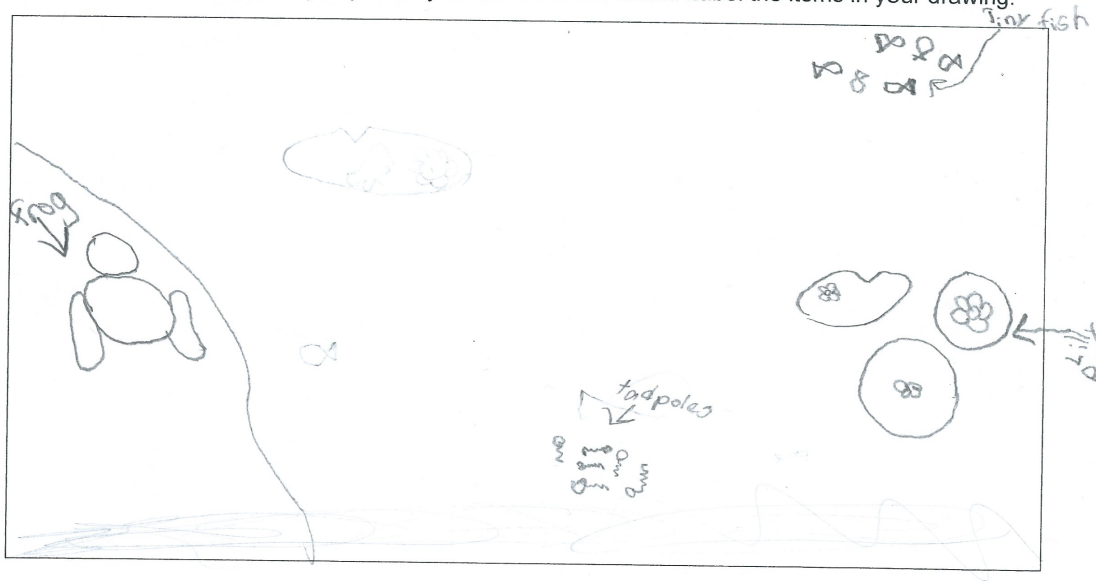
What's in the Water?

107

Imagine that you are looking down into a creek at ONSC. What would you expect to see? Explain your thinking.

Tiny little fish. A bunch of tadpoles and frogs. I also think there will be some lilly pads

In the box below, draw what you predict you will see in the creek. Label the items in your drawing.



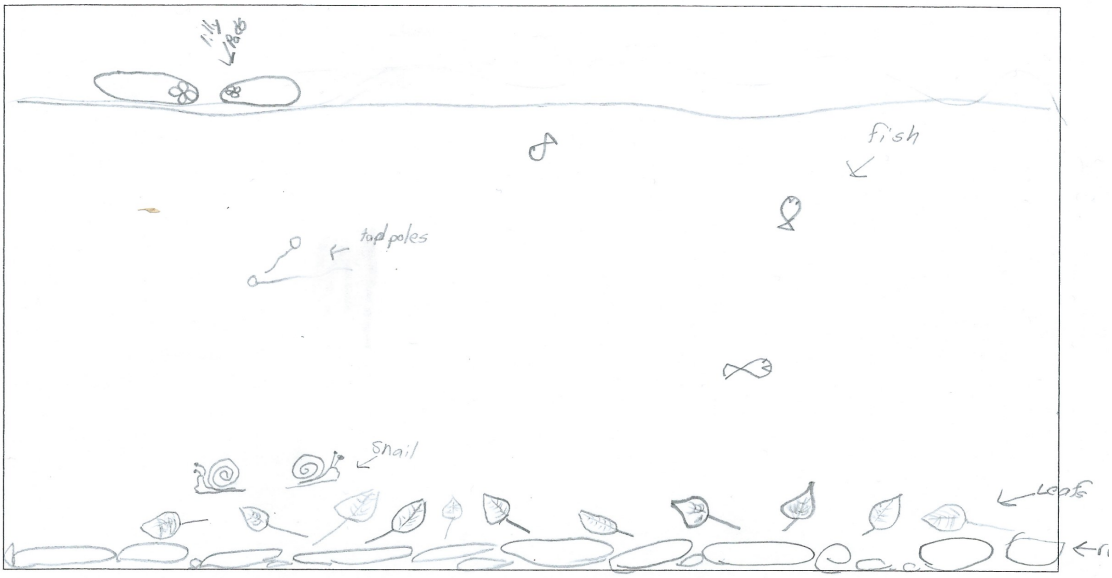
Do you think that the organisms living in the creek can tell you anything about the quality of the water in the creek? Yes ____ No ____ Explain your answer below.

Figure 3-A: A sample pre-assessment as part of a paired assessment that improved in score

Name [redacted] Post-assessment

What's in the Water?

1. In the box below, draw what you saw in the creek at ONSC. Label things in your drawing.



What did you actually observe in the creek? Did anything surprise you? Explain your answer.

I saw lots of fish and other things. 1 thing that surprise me is the there was no dirty water that could kill the fish.

Do you think that the organisms living in the creek can tell you anything about the quality of the water in the creek? Yes ✓ No ____

What did you learn about the connection between the creek critters and water quality? Explain.

creek critters will need to stay in water so they don't die.

Figure 3-B: Matching post-assessment as part of paired assessments (Figure 3-A) demonstrating a score that improved from pre-to post-assessment

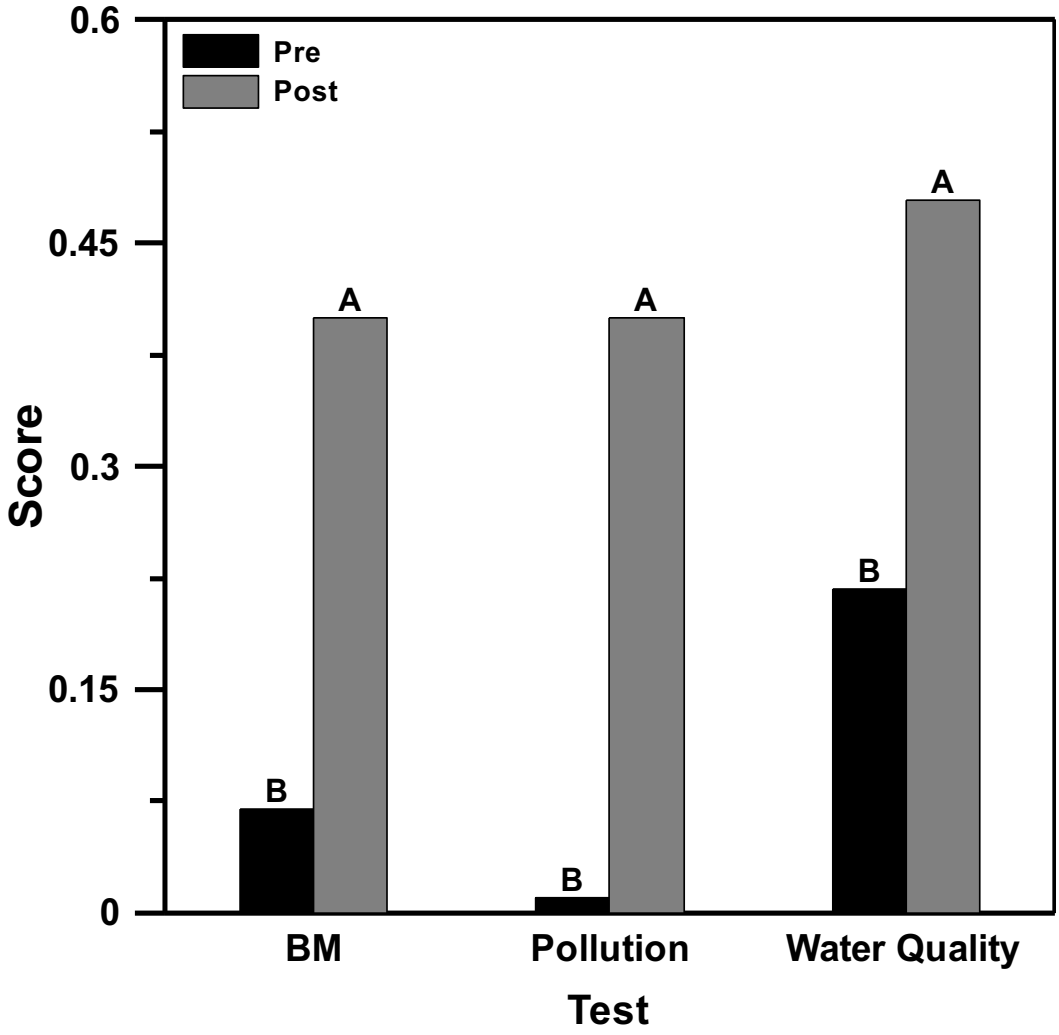


Figure 4. Statistical Significance in the Pre- and Post-Assessment categories of Water Quality, Benthic Macroinvertebrates, and Pollution. Bars with different letters are statistically different at α=0.05.

Table 1. Percent difference in pre-and post-assessment cores based on answer occurrence in the 217 participants. Percent difference values were found by subtracting pre-assessment scores from post-assessment scores and dividing by the number of participants.

	Test		
Subject	Pre-Assessment Score	Post-Assessment Score	Difference (%)
Animals	87	8	-36.41
Fish	147	70	-35.48
Frogs	85	19	-30.41
Drawing	79	55	-11.06
Plants	61	42	-8.76
Tadpoles	20	19	-0.46
Rocks	64	70	2.76
Pollution	2	9	3.23
Insects	27	45	8.29
Water quality	47	104	26.27
Benthic Macroinvertebrates	16	87	32.72