Abstract

What’s in Our Waters Jr. (WOW Jr.) is an environmental outreach program designed to teach fourth grade elementary students about watershed protection. This program is unique because of the partnership that brings together students, teachers, scientists, and water resource professionals to promote science education and environmental stewardship in the classroom through mentorship and hands-on learning activities. WOW Jr. is co-led by the Clemson University Cooperative Extension Service (4-H Youth Development and Water Resources Programs) and Clemson University Environmental Toxicology Graduate Program. The major themes covered in WOW Jr. are watersheds, water pollution, and water conservation and protection. The curriculum is designed to help teachers meet several South Carolina academic standards for fourth grade science. Pre- and post-surveys administered to students to assess program effectiveness and progress over time show that engagement with science professionals increases achievement of state standards and knowledge of watershed protection by environmental stewardship, and it alters students’ perceptions of scientists.

Key Words: Watershed protection; fourth grade science; water pollution; environmental outreach; mentorship.

Introduction

Humans are dependent on the natural environment (Sutherst, 2004; Bell et al., 2007; Tie & Cao, 2009), and the actions of human society have a direct impact on the environment (Zolitschka et al., 2003; Gale et al., 2004; Dumont et al., 2013). To maintain a healthy and habitable natural world, it is imperative to responsibly use and protect the environment through sustainable practices and conservation, which is defined as environmental stewardship (Leopold, 1949). It is important that the concept of environmental stewardship is introduced at an early age, as children who engage in scientific education activities early also develop positive attitudes toward scientific disciplines (Lindahl, 2005). This attitude translates to higher achievement in science, technology, engineering, and mathematics (STEM) areas later in life, as well as increased likelihood to pursue STEM-related careers (McClure et al., 2017). By engaging children in educational activities centered around environmental science and stewardship, a new generation of more environmentally conscious members of society will be established.

Although teaching young students about their personal responsibility as environmental stewards is important, it is a complex topic and often not discussed at great lengths in the classroom, as teachers must also prioritize covering science topics that are part of their state’s academic standards for a particular grade level. To reinforce the concept of environmental stewardship while also covering other critical science content, supplemental instruction by professionals and mentors working in science disciplines has been found to benefit both students and teachers (Goodnough, 2004; Amato-Henderson et al., 2009). For example, the combination of mentorship experience paired with problem-based learning exercises outside of regular class instruction increased the curiosity, inquiry, and scientific thinking among elementary and middle school students. Students also demonstrated increased knowledge content and improved problem-solving skills (Leas et al., 2017). In addition, professional mentors may be able to cover specialized topics that teachers are not as comfortable teaching (Karp et al., 2010). Mentorship experiences in general often augment motivation and improve behavior of elementary students (Rahill et al., 2017). Moreover, studies have shown that parents learn concepts for, from, and with their children, especially in STEM-related subjects (Ginsburg et al., 2008). Volk and
Cheak (2003) found that environmental education programs in elementary and middle schools not only have a positive impact on parents’ attitudes and involvement in environmental stewardship but also on the surrounding communities at large.

The What’s in Our Waters Jr. (WOW Jr.) outreach program brings local water resource professionals and university scientists into the classroom to engage young students in educational activities centered around watershed protection and stewardship. WOW Jr. is an environmental outreach program that stemmed from the high school WOW program (Ware et al., 2019) and targets local fourth grade students. This program involves a unique partnership between elementary students and teachers, scientists, and water resource professionals that promotes science education and environmental stewardship in the classroom through mentorship and hands-on learning activities. Through this supplemental education to young students, there is also a hope that parents and, by extension, the community are positively influenced by this program and what it aims to achieve. This paper serves as an introduction to this novel curriculum and provides some anecdotal results of success from the WOW Jr. program’s first two years of implementation in two elementary schools in South Carolina.

Table 1. Alignment of WOW Jr. lessons with South Carolina’s academic standards and performance indicators for fourth grade science.

| SC Standard                                                                 | Lesson                                | Concept Presented in the Program                                                                 |
|----------------------------------------------------------------------------|---------------------------------------|--------------------------------------------------------------------------------------------------|
| 4.S.1 “The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understanding of science content.” | Scientific method                      | Students use a scientific notebook as practical introduction to the scientific method, with the lesson’s key words defining the steps. To practice science inquiry skills, students develop hypotheses before performing the experiment. |
| 4.S.1B “Conceptual Understanding: Technology is any modification to the natural world created to fulfill the wants and needs of humans. The engineering design process involves a series of iterative steps used to solve a problem and often leads to the development of a new or improved technology.” | Stormwater                             | Students use the scientific inquiry process to identify stormwater pollution sources and possible environmental impacts. |
| 4.L.5 “The student will demonstrate an understanding of how the structural characteristics and traits of plants and animals allow them to survive, grow, and reproduce.” | Water quality & macroinvertebrates     | Students practice the scientific method by testing water quality. |
| 4.S.1 “The student will use the science and engineering practices, including the processes and skills of scientific inquiry, to develop understanding of science content.” | Stormwater                             | Students engineer possible solutions to stormwater pollution or ideas for how to prevent it from impacting aquatic habitats in the first place. |
| 4.E.2 “The student will demonstrate an understanding of the water cycle and weather and climate patterns.” | Groundwater pollution                  | Groundwater lesson discussion and activity help students gain understanding of the water cycle and how weather patterns influence water supply. |
Program Framework

The WOW Jr. outreach program is co-led by the Clemson University Environmental Toxicology graduate program and the Clemson University Cooperative Extension Service (4-H Youth Development and Water Resources Programs). Mentors who volunteer for the program include local professionals and both undergraduate and graduate-level university scientists who specialize in an environmentally relevant STEM field. Mentors meet with fourth grade students from each school for one hour each month to present and teach a topic about watershed protection (see the Supplemental Material available with the online version of this article.) Each lesson consists of a brief presentation in the form of an interactive PowerPoint followed by a hands-on experiment or activity related to the information presented. Throughout each lesson, each student records definitions to key words, the main scientific question related to the activity, and their hypothesis, observations, and conclusions in their scientific notebook. Students are broken up into small groups of about four students to complete the activities. Following the activity, each lesson is concluded with a class discussion about what the students observed during the activity and their conclusions about the topic covered that day. The main responsibility of the fourth-grade teachers during this time is to provide classroom management for the guest mentors. All lessons are designed to align with one or more of South Carolina’s academic standards and performance indicators for fourth grade science (Table 1) (South Carolina Department of Education, 2014). The program is evaluated using data gathered from state standard assessments and pre- and post-surveys administered to students. A detailed description of each lesson, activity, and South Carolina academic standard alignment is in the Supplemental Material available with the online version of this article. (Also, you may request PowerPoint presentations and activity instructions for each lesson by contacting the corresponding author.)

Lesson 1: Scientific Method

In the first lesson, students are introduced to the mentors and the WOW Jr. program. The purpose of this lesson is to review the scientific method and apply it to an experiment. Each student is given a scientific notebook, and mentors discuss the components of the notebook, including the scientific method. To begin the lesson’s presentation, students are asked simple questions such as “How do you describe a scientist?” and “What would you want to record in your scientific notebook?” Students are encouraged to be creative with their answers, which may involve pictures as well as short descriptions. Following the introductory presentation, students conduct an experiment in small groups with the help of mentors to investigate the concepts of cohesion and adhesion through a water transport test. This first experiment sets the stage for students to understand how these unique properties of water are also what causes water to become easily polluted and how pollution can be transported from one body of water to another.

Lesson 2: Stormwater

This lesson was developed to introduce students to sources of pollutants and how difficult it can be to clean up polluted water, even using engineered solutions. The lesson covers the difference between point source and nonpoint source (NPS) pollution, the types of NPS pollutants, and how these pollutants end up in our waterways and their effects on aquatic habitats. Students brainstorm ways to prevent and clean up these pollutants in the environment. For this lesson’s activity, mentors set up a small aquarium for each group of students. The aquarium contains clean water and objects that represent aquatic plants and animals. Mentors give students items that represent NPS pollutants (e.g., oil, litter, pesticides, fertilizer, pet waste) to add to their aquatic habitats. Each student then picks one tool to attempt to clean up their polluted habitat. Following this activity, mentors discuss factors to consider when cleaning the habitats. These factors include, but are not limited to, where the pollution comes from, what it is doing to the environment, how effective their cleaning method is, and how the cleaning method may affect the environment and organisms within it.

Lesson 3: Water Quality & Macroinvertebrates

This lesson discusses various water characteristics and how macroinvertebrates are used as bioindicators to monitor water quality. Students are introduced to water chemistry tests including pH and dissolved oxygen, as well as the relationships between types of macroinvertebrates and a healthy or unhealthy aquatic habitat. Mentors begin the lesson by asking students questions, including “Can we tell if a stream is healthy just by looking at it?” and “What do macroinvertebrates and bacteria tell us about water quality?” Mentors explain how results from water chemistry tests and macroinvertebrate identification indicate the water quality of a stream. Students then conduct water quality measurements on a stream sample to assess the overall health of the stream. Students rotate through three different water quality testing stations: pH, dissolved oxygen, and macroinvertebrate identification. After completing all stations, students compare their test results with the entire class and conclude whether or not the stream water is healthy.

Lesson 4: Litter Pollution & Recycling

During this lesson, students are introduced to litter as a major stormwater pollutant in addition to what and how to recycle. Mentors first ask students, “What is the only thing that should ever go down a storm drain?” Students watch a short video that explains how litter from stormwater pollution can affect aquatic animals. Mentors then ask students to come up with ideas of how to keep litter from getting into storm drains. After this introduction, students participate in a sorting game to determine which items can be recycled. Following the game, students and mentors discuss why it is important to reduce, reuse, and recycle and how students can continue to do this at home.

Lesson 5: Groundwater Pollution

This lesson familiarizes students with the concepts of aquifers and groundwater and how pollutants can contaminate groundwater. Mentors begin the lesson by depicting how aquifers are rocks underground that “hold” water in their pore spaces, and these ideas are further explained in a short educational video. The uses of groundwater and how pollutants can contaminate our groundwater are discussed between mentors and students. For this lesson’s activity, students create an edible aquifer using ice, soda, and ice cream. Students observe how quickly pollution can contaminate groundwater, and resulting implications of this are discussed with mentors.

Lesson 6: Plants & Erosion

The purpose of this lesson is show students how erosion can affect water quality and how plants play an important role in reducing stormwater runoff and erosion. During the presentation, mentors explain and discuss with students why plants are important to humans, the different uses of plants, and how plants can improve water quality. For
this lessons activity, students conduct an experiment that compares stormwater runoff between two types of ground cover. Students record their hypotheses, observations, and conclusions before, during, and after water is poured over each type of ground cover. Following this experiment, students and mentors go outside and plant seeds in the school’s garden, enforcing the idea that students can also be active environmental stewards and reduce stormwater runoff.

○ Initial Findings & Discussion

The establishment of a partnership between local water resource professionals and university scientists working together with elementary school teachers and students provides a unique classroom dynamic and learning environment that greatly benefits all parties involved. Students receive supplemental instruction to their fourth-grade science curriculum in an interactive and engaging manner from environmental scientists and professionals who are passionate about their job and educating others. In addition, the teachers, eager to provide their students with additional methods to master science standards, also learn alongside their students during the program, as the information presented is relevant to all ages and not just children.

The effectiveness of this unique partnership and program is evaluated each year by examining publicly available state standard assessment results and student responses to program surveys. Out of all of the science standards for fourth grade, the standard “Science and Engineering Practices” aligns most closely with the WOW Jr. program and is the only standard in which all of the program’s lessons align in at least one way. Publicly available assessment results are reviewed for the percent of students whose test performance shows weakness and a need for further instruction (South Carolina Department of Education, 2022). Results show a decrease in the percentage of students in the poor testing performance category during the years the WOW Jr. program was in place (2017–2018 and 2018–2019) compared to the school year when the program did not exist (2016–2017) (Figure 1).

Additionally, student responses to pre- and post-surveys are examined to determine if students increased their understanding of the main concepts presented throughout the duration of the program. Two questions asked within the surveys that are essential to measuring program impact are “How can water become polluted?” and “How can you stop water pollution?” Examples of common student responses to the first question from the pre- and post-surveys are “it can become dirty” and “plastic, oil, and dirt cause polluted water,” respectively. Examples of common student responses to the second question from the pre- and post-surveys are “you can take it out” and “we can help by picking up trash and recycling it,” respectively. The supplemental question “What is a scientist?” was also posed to students in both the pre- and post-surveys in order to gain a general understanding of how young students perceive those working in the scientific community. Students were asked to draw a picture to accompany their answer to this question. We found that these drawings became substantially more diverse and less stereotypical in the post-survey responses compared to pre-survey responses (Figure 2).

Several improvements and additions have already been made to the WOW Jr program, including the development of mentor training videos to ensure that all mentors (e.g., water resource professionals and university scientists) cover the same information in each classroom, a science notebook for each student to record their findings as they work through the scientific method for each lesson, and the use of interactive PowerPoints at the beginning of each lesson to provide more structure and visual aids about topics and concepts covered. More changes will continue to be made to the program, including annual updates to the PowerPoint presentations to keep up with current environmental issues, the addition of take-home activities that involve parents and the broader community (e.g., discussing and practicing recycling at home), and utilizing an interactive groundwater pollution model (rather than using pictures) for Lesson 5 to help students gain a more visual understanding of the concepts presented.

In summary, the WOW Jr outreach program is a valuable supplement to the fourth-grade science curriculum for both teachers and students, providing expert education resources on watersheds, water pollution, and water conservation and protection topics. Teachers elsewhere can take advantage of the partnerships and program structure presented here by utilizing their own county or community cooperative extension service (U.S. Department of Agriculture, n.d.) and/or nearby institution of higher education. The mentorship experience and problem-based learning exercises applied by the WOW Jr. program help to increase learning and interest in science education.

![Figure 1](image1.png)

**Figure 1.** Percentage of fourth-grade students whose test performance shows weakness and a need for further instruction for the science standard “Science and Engineering Practices.” State standard assessment results comparing school years with the WOW program in place (2017–2018 and 2018–2019) to a school year without the program (2016–2017) for two elementary schools (A) and (B).

![Figure 2](image2.png)

**Figure 2.** Examples of fourth grade students’ pre-survey (A) and post-survey (B) responses to the question “What is a scientist?”
among elementary students. This program will continue to expand and implement changes to further enhance students’ understanding of watershed protection through environmental stewardship.

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