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Urban Elementary Students' Views of Environmental Scientists, Environmental Caretakers and Environmentally Responsible Behaviors

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URBAN ELEMENTARY STUDENTS' VIEWS OF ENVIRONMENTAL SCIENTISTS, ENVIRONMENTAL CARETAKERS AND ENVIRONMENTALLY RESPONSIBLE BEHAVIORS

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ABSTRACT

URBAN ELEMENTARY STUDENTS' VIEWS OF ENVIRONMENTAL SCIENTISTS, ENVIRONMENTAL CARETAKERS, AND ENVIRONMENTALLY RESPONSIBLE BEHAVIORS

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The purpose of this research was to determine the nature of the relationship between urban elementary fifth graders, environmental workers, and the environment. The study examined 320 urban fifth grade elementary students' drawings of environmental scientists (DAEST) and environmental caretakers (DAECT). Additionally, semi-structured interviews were included to elucidate student illustrations. The study's sample represented one-third of all fifth graders in the mid-Atlantic school district selected for this research. Approximately 5% of participants were chosen for follow-up semi-structured interviews based on their illustrations.

A general conclusion is some of the stereotypes, particularly related to gender, revealed in prior research (Barman, 1999; Chambers, 1983; Huber & Burton, 1995; Schibeci &Sorensen's, 1983; Sumrall, 1995) are evident among many elementary students. Male environmental scientists were drawn twice as often as female environmental scientists. Females were represented in more pictures of environmental caretakers than environmental scientists. Students overwhelmingly drew environmental scientists (98.1%) and environmental caretakers (76.5%) working alone.

Wildlife was noticeably absent from most drawings (85%). Where wildlife was included, it was most often birds (6.9%) and fish (3.1%). More than one species was evident in only 2.5% of the pictures.

Fifty percent of environmental caretakers were shown picking up trash from land. Actions such as reducing resource use occurred in only 13 out of 319 pictures (4.1%). Pictures of environmental caretakers sharing knowledge were even less common (2.5%). Almost 22% of females drew multiple individuals compared to 18.5% drawn by males. Females were more likely to show individuals collaborating (22.4% to 16.8%) while males were more likely to show individuals working in opposition (5.2% to 2.0%).

"Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference."
--Robert Frost, 1920

I would like to dedicate this to the special people in my life who took this journey with me. To my first teachers, Mom and Dad, thank you for instilling in me a love of learning and a reverence for the beauty and power of nature. To Donna, I am so lucky you are my best friend for life. As Proust said, "people who make us happy, ...are the charming gardeners who make our souls blossom". To my sister Laura, our late night cross-country phone calls are always a source of laughter and inspiration for me. To my children Erin, Megan, Dustin, and Kristin, thanks for your love and support. You will always have mine. Finally, I would like to dedicate this to my brother, SSGT. Eric Horne, currently in his third deployment in Iraq. I am humbled by your resolve and strength of character. You are my hero.

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CHAPTER I

INTRODUCTION

The number of family owned farms in the United States dropped from 40% of households in 1900 to 1.9% in 1940 (Vobejda, 1993). This rapid decrease has led many to suggest this generation may be the first in the United States to grow up without a familial attachment to the land. Adding to the concern about children's access to family farms is the recent decrease in children's free time to explore nature. Children's free time has decreased by nine hours a week over the last twenty-five years (Louv, 2008). So many things compete for children's time minimizing or eliminating unstructured time spent simply exploring outdoors. For example, children aged six to eleven spend approximately "thirty hours a week looking at a television or computer monitor" (Louv, p. 47). Many contend this is not a uniquely American problem.

Louv (*Last Child in the Woods*, 2008) coined the phrase "nature deficit disorder" to describe how the loss of time exploring nature has impacted children. His book helped fuel the environmental education movement with assertions such as "the protection of nature…depends on the quality of the relationship between the young and nature" (p. 156). Still many environmental education advocates believe society is not fostering the necessary primary experiences between children and their natural surroundings. Primary experiences in nature build and strengthen children's affective bonds with nature (Louv, p. 65). It is generally accepted that people will not work to preserve that which they do

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not value. There is a growing call for environmental education (EE) curricula to be incorporated into public schools to ensure today's youth connect with nature (Harris, 2005).

Background

Environmental Education

Today's citizens are members of an interconnected global village. As the Earth's population grows and resources become threatened, knowledge and skills related to the environment are essential to all global citizens (Bybee, 2008). Science education should aim to equip students with the skills necessary to take responsible actions related to environmental concerns (Colucci-Gray, Camino, Barbiero, & Gray, 2006). Advocates view environmental education (EE) as a means to foster reverence for nature subsequently impacting the adoption of environmentally responsible behaviors. While there are many factors involved in the development of environmentally responsible behaviors that are beyond educators control (e.g., socioeconomic status and gender), Chawla and Flanders Cushing (2007) argued that environmental educators can foster students' opportunities to "gain knowledge, form positive attitudes about the environment, and practice action skills" (p. 441).

Children deserve an education that is relevant to their lives. Barratt Hacking, Barratt, and Scott (2007) found that children are concerned about the present and future states of the environment. They will inherit many of these environmental problems as adults so they should have educational experiences that equip them with the necessary knowledge and skills required of environmentally literate citizens.

Environmental Literacy

Roth (1991) first used the phrase "environmental literacy" in 1968. Disinger & Roth (1992) later elaborated that environmental literacy focuses on four central issues: "the interrelationships between natural and social systems; the unity of humankind with nature; technology and the making of choices; and developmental learning throughout the human life cycle" (p. 5). Disinger & Roth (1992) concluded that environmental literacy "draws on six major areas: environmental sensitivity, knowledge, skills, attitudes and values, personal investment and responsibility, and active involvement" (p. 5). More generally, the six major areas can be grouped under the headings "affect" and "behavior". It is through learning to care about the environment that students may be inspired to make environmentally responsible choices. Work by Littledyke (2008) confirmed the importance of cognitive and affective experiences in the development of environmental literacy.

The *No Child Left Inside Act* (2009) originated to advance EE in our nation's schools. Supporters of the legislation claim "in addition to the many academic and conservation benefits of EE, business leaders increasingly believe that an environmentally literate workforce is critical to their long-term success" (NWF, 2009, http://www.greenhour.org). Proponents see EE as a way to rekindle the Earth-child connection and increase the likelihood that environmentally literate citizens and environmental stewards of the future will emerge (NAAEE, 2004).

Environmental Stewardship

The Environmental Protection Agency (EPA) emphasizes the potential of environmental stewardship to help solve some of today's most challenging environmental problems. The agency stresses the millions of little choices made by individuals and companies each day can collectively have a significant impact on the overall health of the environment (EPA, 2009).

The central components of stewardship identified by Dixon, Siemer, and Knuth (1995) include:

> ...the moral obligation to care for the environment...the existence of an ethic of personal responsibility, an ethic of behavior based on reverence for the Earth and a sense of obligation to future generations...placing self-imposed limits on personal consumption and altering personal expectations, habits, and values...taking actions that respect the integrity of natural systems (p. 18).

Individuals demonstrate environmental stewardship through actions and behaviors that benefit the environment. To foster environmental stewardship behaviors in children, they should be provided with numerous opportunities to participate with real issues in the environment (Rudduck & Flutter, 2000).

Benefits of Environmental Education

Benefits to the Environment

Media regularly feature stories on environmental problems. Issues facing the public are numerous and complex (e.g., energy shortages, air and water pollution, and destruction of habitats). Advocates are essential for park preservation and the continuation and expansion of conservation measures. Stewards are needed to protect endangered plant and animal species through activism and education.

Throughout history, individuals have drawn attention to environmental problems, often leading to changes in environmental policies and practices. Almost fifty years ago, Carson's *Silent Spring* (1962) provided a poignant account of the decline in the number of birds near her home. Ultimately, diphenyl thrichloroethane (DDT), a pesticide used by farmers, was identified as the culprit. Because of her vivid exposition and stewardship actions, changes in pesticide use were implemented. Such personal commitment and actions have the potential to bring about positive changes in the environment while also improving the quality of life for humans.

Benefits to Children

Children who spend time outdoors are naturally active. They spend much more time exerting themselves physically than their peers who sit in front of televisions or computers. Lack of activity has been associated with the rise in childhood obesity over the last several decades.

The emotional benefits of time in nature include a reduction in stress levels and notably "the protective impact is strongest for those experiencing the highest level of stressful life events" (Louv, p. 51). Intellectually, time spent outdoors fosters curiosity, creativity, and imagination. Many great inventors such as Ben Franklin reported an affinity for time outside.

Another benefit of EE is that it fosters childhood agency. Bandura (2001) stated agency is essential to human development. Blanchet-Cohen (2008) reported that childhood agency is developing "children's power…to influence or organize events and to engage in the structures that affect their lives" (p. 261). Blanchet-Cohen (2008) reported that EE fosters childhood agency across six dimensions: "connectedness, engaging with the environment, questioning, belief in capacity, taking a stance, and strategic action" (p. 263). EE connects students to real world issues and challenges them to use problem-solving skills that will be required of them as adult citizens and 21st century workers.

A relatively new benefit to children may be related to economics. Individuals who spend time connecting with nature may be seen as more marketable because of the growing demand for green employees and environmentally literate individuals. This is one reason why supporters believe EE is especially needed for urban students. These students are not only likely to spend little time outdoors, but are also often from populations that are underrepresented in math and science fields.

Meaningful Environmental Education Experiences

Effective science pedagogy encourages child-centered, inquiry-based learning that builds on students' current knowledge and perceptions and is relevant to everyday life (NRC, 1996). While many studies have been conducted on the prior knowledge and perceptions of environmental issues with secondary students and older (e. g., Dove, Everett, & Preece, 1999; Shepardson, 2005; Shepardson, Wee, Priddy, Schellenberger, & Harbor, 2007; Yilmaz, 2004), the literature revealed little in regards to studies of elementary students' prior knowledge and beliefs about EE. Because those involved in EE argue it should be introduced to students at a very early age, EE curricula targeting younger audiences are currently being developed or implemented.

Hungerford, Volk, and Ramsey (2000) shared that EE experiences must be owned by students to help them feel empowered. Roth and Lee (2002) echoed these thoughts by claiming the curriculum should be a "lived curriculum" (p. 275). Ballantyne, Packer, and Everett (2005) determined students could learn knowledge and skills by listening to an adult. They also found that for students to develop attitudes and behaviors (actions), they needed first hand experiences in the environment. These first hand experiences should be part of an engaging curriculum based on students' prior knowledge and perceptions.

Studies on Students' Perceptions

Students' Perceptions of Scientists

Chambers (1983) conducted seminal research in science education to examine students' perceptions of scientists. He created the Draw-a-Scientist Instrument (DAST) to examine students' beliefs about scientists as evidenced by their illustrations. The instrument has been widely adopted in the field of science education and tested with thousands of students in kindergarten to fifth grade. As a result of these broad ranging studies, seven features about students' images of scientists emerged: 1) lab coat, 2) eyeglasses, 3) facial hair, 4) symbols of research such as lab equipment, 5) symbols of knowledge including notebooks and file cabinets, 6) technology, and 7) relevant captions. Chambers also observed that very few children drew the scientist working outdoors. Most drew the scientist working in a laboratory.

It is important to know if students see features of themselves in scientists. It is also essential to determine if students view scientists' work as connected to the environment. If not, educators and EE curricula need to challenge the stereotypes and misconceptions held by students to make the field of environmental science and careers in environmental science more accessible to all.

Students' Perceptions of Environmental Scientists

Thomas and Hairston (2003) modified the DAST to create a new projective instrument know as the Draw-an-Environmental-Scientist Test (DAEST). They revised the DAST checklist created by Finson, Beaver, and Crammond (1995) to establish a scoring rubric for the DAEST. The DAEST rubric was comprised of three parts: 1) The seven standard images of a scientist from the DAST, 2) Alternative images of scientists (gender, ethnicity, and age), 3) Additional images of an environmental scientist with five indicators (savior of the Earth, work settings, nature of scientific work, type of scientist, and emotions of environmental scientists). The three subsections contained a total of nineteen indicators of environmental scientists.

In Thomas and Hairston's research, the DAEST was administered to 382 junior high students and 375 high school students. Data collected revealed that the majority of junior high and high school students viewed environmental scientists as Caucasian. For the drawings that depicted environmental scientists working outside, most showed them wearing a lab coat or working on a laboratory type table outdoors. The majority of students in both groups limited the work of environmental scientists to data collection. Most of the outdoor illustrations centered on water while overpopulation and air pollution were not included in any of the drawings, indicating these topics need to be infused into an effective EE curriculum.

Klein and Merritt (1994) examined EE materials to determine the extent to which they were aligned with constructivist teaching. They revealed those that exemplified constructivist teaching were responsive to students' prior knowledge and experiences and helped students connect new concepts to prior understandings. Studies with elementary students and the projective instrument (DAST) revealed students' preconceptions about scientists in general. Research with junior high and high school students revealed their perceptions about environmental scientists using the DAEST.

Problem Statement and Research Questions

Though numerous studies of students' perceptions of scientists have been reported, far fewer have been conducted on students' views of environmental scientists. No reports of studies with the DAEST and elementary students were found in a review of the professional literature. Because the DAEST is a modified version of the DAST (designed for elementary students), it would seem likely that the DAEST would be easily modified and suitable for elementary students.

Information from elementary students on prior knowledge and beliefs about environmental scientists would prove helpful in designing an EE curriculum that could connect new knowledge to students' prior experiences and beliefs, as constructivist teaching recommends. Such information would also aid in the development of an EE curriculum that addressed students' misconceptions and stereotypes.

The purpose of this non-experimental mixed-methods study (Creswell, 2009, p. 213) was to learn about urban elementary students' views of environmental scientists, environmental caretakers and students' perceived roles related to the environment. The study was guided by the following research questions:

1. How do students view environmental scientists?
2. How do students view environmental caretakers?
3. How do students view their roles regarding environmental responsibility?
4. Do male and female students' views on environmental scientists, environmental caretakers, and environmentally responsible behaviors differ?

Overview of Study

The study employed a non-experimental mixed-methods design. Participants included 320 fifth grade urban students. Participants were predominantly African Americans (71.6%). Caucasian students represented 21.6% of the sample with the remaining 2.8% of participants identified as Hispanic, Asian, or Native American. A greater percentage of participants were male (54% male to 46% female). Students represented a diverse range of abilities, as all students with disabilities who had Individualized Education Plans (IEPs) and were placed in general education classrooms were included in this research. Most students were from low socioeconomic status as defined by their eligibility for free and reduced meals.

Multiple data collection strategies were employed in this study. An overview is provided here. Each will be discussed in more detail in Chapter III. The first instrument, the Draw-an-Environmental-Scientist Test (DAEST), required students to draw a picture of an environmental scientist working. Students were also asked to provide one or two sentences describing their illustration. The second instrument employed in the study was the researcher created Draw-an-Environmental-Caretaker Test (DAECT), modified from the DAEST. Students were asked to draw a picture of someone taking care of the environment and explain in one or two sentences what was happening in their picture. The last data source was the Semi-Structured Interview (SSI). The SSI protocol consisted of 9 open-ended questions about students' perceptions of environmental scientists, environmental caretakers, and students' environmental roles.

All participants completed the DAEST and the DAECT instruments on the first day of their regularly scheduled environmental science unit. These data were collected as part of a larger National Oceanic and Atmospheric Administration (NOAA) funded project, Project SEARCH. Follow-up SSI were conducted with selected participants within three weeks of their DAEST and DAECT drawings.

To enhance the credibility of the findings, triangulation was used to compare results obtained across measures. Merging of both quantitative and qualitative data and analyses helped to better describe and explain trends in students' views (Creswell, 2009, p. 121).

Limitations

Instrumentation may have presented a threat to the validity of the findings. Though the DAEST has been used extensively, no published reports of its use with elementary students were found. This raised the question of whether or not this measure was appropriate for elementary students. The DAEST is a modified version of the DAST, which has been used with thousands of elementary students. To enhance reliability, the DAEST was piloted tested with elementary students similar to those in the proposed study. Reliability of the DAEST was further enhanced through the use of multiple raters to obtain an acceptable level of inter-rater reliability.

The DAECT is researcher-developed and therefore instrumentation is also a potential threat for this research. However, numerous methods were used to minimize this threat and enhance the measure's reliability and validity. It was adapted from the DAEST and underwent multiple expert reviews and revisions. The DAECT was pilot tested, revised, and re-piloted with students similar to those in the proposed study. A scoring rubric was developed from the pilot. Multiple raters scored the same set of drawings using the rubric and obtained a minimum inter-rater reliability measure of .85. Responses to the semi-structured interviews were similarly subjected to stringent qualitative analyses protocols.

Multiple raters were again employed to enhance reliability and validity of the findings.

Overview of Chapters

Chapter II provides a comprehensive overview of empirical research published in top tier scholarly, peer-reviewed journals. The review focuses on recent literature (primarily the last 20 years) but also includes older, seminal works to provide a historical context. An overview of populations, methodologies, and findings are reported as well as identified gaps in the literature. Following the literature review, the research questions and hypotheses for the study are presented.

Chapter III provides a detailed description of the methods, participants, measures, and procedures of the study. All constructs in the study are operationally defined in this chapter. A discussion of the content, length, and format of each measure is presented. Instrument administration and measures of validity and reliability are discussed. Also, an overview of data analysis techniques for the various data sources is presented.

Chapter IV presents data obtained on students' perceptions of environmental scientists, environmental caretakers, and environmentally responsible behaviors. Data are reported for each of the three instruments employed in this research. Frequencies in responses are reported for each instrument and statistically significant differences between male and female students are identified.

Chapter V provides a summary of the study and presents findings for each of the four research questions that guided the research. Conclusions are drawn based on the results and are discussed in the context of the literature. Limitations of the research are identified and addressed. Recommendations are provided for practitioners and researchers based on the data from this research and the literature.

CHAPTER II

REVIEW OF LITERATURE

This chapter presents a review of studies on students' perceptions of science and, more specifically, environmental science. Findings by demographic variables are identified. Instruments used in this area of research are examined. The chapter concludes with an identification of gaps in the literature, a problem statement, research questions, and overview of the present study.

A New Field of Inquiry

Groundbreaking Research

In the fifty years since Mead and Metraux's (1957) seminal study, research on students' perceptions of scientists has continued (e.g. Chambers, 1983; Finson et al, 1995; Losh, 2008; Shibeci & Sorensen, 1983). The interest in student perceptions remains, in large part because of the emphasis on constructivist pedagogy in science education reform (AAAS, 1989; NRC, 1996). In order to develop meaningful curriculum and utilize teaching strategies that best match students' prior knowledge and perceptions, students' views must first be identified.

Mead and Metraux's (1957) groundbreaking study involved the examination of 35,000 essays about scientists written by American high school students. The researchers provided students with open-ended prompts requiring a written response. Mead and Metraux's analyses identified stereotypical attributes of scientists as perceived by these students. According to student data, a scientist tended to: be male, wear a white coat, wear glasses, use black notebooks, be older, use equipment, read all of the time, and know dangerous things (1957, p. 386-387).

Providing different prompts, however, resulted in contrasting response patterns from the students. When students were asked about a scientist in general, responses tended to be favorable and included "devoted" and "works for the benefit of mankind" (1957, p. 385). Yet, when students were asked about scientists in a personal way (boys were asked "what kind of scientist they would like to be" while girls were asked "what kind of scientist they would like to marry") negative images of scientists were revealed (1957, p. 385). Some of the cited negative characteristics included: "he spends his days indoors, his work is uninteresting, he has no social life, he neglects his family, he is never home, he is always reading a book" (1957, p. 385).

Projective Instruments and Students' Perceptions of Scientists

Within ten years of the publication of Mead and Metraux's work, Chambers (1983) began similar research with elementary students. His eleven-year study (1966 to 1977) involved students from three continents and the development of a new instrument, the Draw-a-Scientist Test (DAST). A projective instrument, the DAST was modeled after an intelligence test created for children by Goodenough (1926). The DAST allowed the collection of data from young students possibly lacking the literacy skills necessary to complete written response instruments.

In Chambers' study, the DAST was administered to 4,087 American, Australian, and Canadian students in kindergarten through fifth grade. Regular classroom teachers administered the instrument to their students. For comparison purposes, approximately one-fourth of the students were asked to draw a person in addition to drawing a scientist.

Chambers developed a list of seven indicators of students' images of a scientist based on Mead and Metraux's findings: lab coat, glasses, facial hair, equipment, books, creations (products of science) and captions (Chambers, 1983, p. 258). Drawings were scored on a scale of one to seven. One point was given for each indicator category evident in student drawings. Students could not receive more than one point for any given category. For example, the use of multiple captions in an illustration would still result in a score of one for captions. An average student score was obtained for each grade level and socioeconomic status (determined by school) for comparisons. Chambers identified variations in students' use of stereotypical indicators of scientists based on different population variables. Commonly, variations were observed as a function of grade level, socioeconomic status, ethnicity, and gender. These are described further in subsequent paragraphs.

Population Variables and Stereotypical Indicators of Scientists

Age/Grade Level

Researchers revealed a relationship between the age of an individual and the use of stereotypical images of scientists in students' drawings. Chambers' (1983) data showed the average number of stereotypical images increased with students' grade levels. He also found kindergarten and first grade students often did not include any stereotypical indicators in their drawings. He observed that second graders began to show signs of stereotype development while fifth graders tended to display as many stereotypical indicators as most adults. Schibeci and Sorensen (1993) and Sumrall (1995) reported similar findings. These studies confirmed that the stereotypes revealed in Mead and Metraux's study of high school students were evident among many elementary students.

Ethnicity

Students' ethnicities were also found to be related to the use of stereotypical indicators of scientists. Schibeci and Sorensen (1993) administered the DAST to elementary students at two schools in Australia. One school served primarily white, urban students. The other served predominantly rural, Black students. They found that Caucasian students were more apt to use stereotypical images of scientists than their Black peers.

Sumrall's (1995) work extended the research of Schibeci and Sorensen (1993) by including older students. He administered the DAST to 358 Louisiana students in grades one through seven. Sumrall's analyses showed a large difference in the use of stereotypical images between races occurred at the lower elementary grades. He reported that the differences decreased as students moved to upper elementary grades.

Sumrall (1995) further noted differences in the race of the scientists drawn by African American and Caucasian students. African American children drew their scientist as African American 50 out of 99 times (50.5%) while Caucasian students drew Caucasian scientists 224 out of 259 times (86.5%). Similarly, Barman's (1999) research supported that the majority of students continued to view scientists as Caucasian (69% for K-2, 80% for 3-5, and 74% for 6-8).

Socio-Economic Status

Studies show the differences in stereotypical indicators along socioeconomic status (SES) lines have been mixed. Chambers (1983) noted students of lower socioeconomic status tended to use fewer stereotypical indicators in their drawings and the indicators often did not emerge until fourth or fifth grade. Schibeci and Sorensen (1993) corroborated the difference in stereotypical indicator use along socioeconomic lines.

Buldu's (2006) study with Turkish elementary students (ages 5 to 8) revealed contrary findings. These data showed more stereotypical images of scientists were used by students whose parents were from lower socioeconomic positions. He also found students with parents of higher socioeconomic status tended to draw more alternative images of scientists. These conflicting findings highlight the need for further research in this area. No definitive conclusions can be made about SES and stereotypical indicators based on the use of the DAST alone because it was modeled after an intelligence test and intelligence may be a confounding variable in the findings. The different findings may also be related to the challenges of separating SES from other variables such as culture.

Gender

Studies on the used of stereotypical indicators by student gender have yielded consistent results. Research by Chambers' (1983) included a sample of 4,807 elementary students. Forty-nine percent (2,355) of those students were females. Yet, only twenty-eight of all students included in the study drew a picture of a female scientist (.58%). All of the female scientist pictures were drawn by female students. These data suggested that none of the boys (51% of the population) viewed a scientist as female.

Sumrall's (1995) study of 358 students in grades one through seven found that females drew a scientist of their gender 67 out of 164 times (40.8%) while boys drew a scientist of their gender 165 out of 194 times (85%). Chambers' data were collected between 1966 and 1977 while Sumrall's were collected about twenty-five years later. The increase in the percentage of students who drew female scientists from Chambers' study to Sumrall's study, may be a reflection of positive socio-cultural changes in the perceived role of women as well as science education reform efforts (Barman, 1999).

The effectiveness of curriculum designed to counter students' stereotypes was examined by Huber and Burton (1995). They administered the DAST to 223 nine to twelve year olds. Using a coding tool they developed with nine categories, they found boys included more stereotypical indicators in their drawings of scientists. A Chi-square analysis revealed the differences to be significant at the .05 level for six of the nine categories. After a treatment phase, more drawings were obtained. The results showed the treatment was significant in reducing students' use of stereotypical images of scientists. The greatest change was noted in boys' drawings possibly because they demonstrated a greater use of stereotypical indicators in the pre-test. The findings of this study showed effective instruction can mitigate students' stereotypical perceptions of scientists. These findings support the need to identify students' perceptions to minimize sexist stereotypes and promote more effective and equitable curriculum.

Barman (1999) collected DAST and interview data from 1,504 students in kindergarten through eighth grade from across the United States. He used Finson et al's (1995) scoring checklist (DAST-C) to analyze the drawings. Barman disclosed that as students' grade levels increased, so did the percentage of students (both male and female) who drew a male scientist. Still, the percentages were lower (58 % for K-2, 73% for 3-5, and 75% for 6-8) than earlier studies. Barman (1999) speculated that the lower percentages relative to earlier research might further reflect changes in socio-cultural norms and science reform efforts to increase the percentages of women and underrepresented populations in science. The prevalence of alternative images of scientists, such as females, in students' drawings is of interest to researchers because these images may show a break from previous patterns noted across gender, ethnicity, and age.

Alternative Images of Scientists

A checklist for scoring the DAST developed by Finson et al, the DAST-C (1995), included the use of alternative images of scientists in students' drawings. Alternative images included females, ethnicities other than Caucasian, and younger scientists. Indications of danger were also incorporated into alternative images in the DAST-C as well as indicators of secrecy or a picture of a "mad" scientist in students' drawings. Location of scientists' work arose as another area for alternative images. Traditional images drawn by students showed a scientist working in a lab. Rarely did students draw a scientist working outside. Chambers' (1983) study revealed that students tended to perceive scientists as working indoors. Only .2% of English speaking students drew a scientist in nature compared with 2.5% of French speaking students and 4.5% of Australians.

Analyses of Drawings and Measures of Validity/Reliability

Because several studies have employed the DAST, an examination of the tool's psychometric properties is warranted. Chambers used seven indicators from Mead and Metraux's (1957) study as a checklist for scoring the students' drawings of scientists. To establish validity, Chambers asked one-fourth of the subjects to draw a person and then draw a scientist. Indicators identified in scientist drawings were compared to drawings of people.

The DAST was determined to be a reliable instrument for measuring trends across different age groups at the elementary level by comparing DAST data for Australian students with geographic, ethnic, and socioeconomic diversity (Schibeci & Sorensen, 1993). They obtained an overall inter-rater reliability score of .86. They further obtained inter-rater reliability scores for subgroups within the larger sample. The obtained values ranged from .78 to .98. Schibeci and Sorensen (1993) questioned whether validity of the DAST could ever really be obtained. They purported to do so would require comparing children's images to the "real" image of a scientist, a hypothetical construct. They claimed this would be difficult to do because of continued debates about the true characteristics of scientists.

An earlier coding tool for the DAST was developed and pilot tested in 1993 with nine to twelve year olds (Huber & Burton, 1995). Based on responses from the pilot test, Huber and Burton changed the instructions from "Draw a scientist" to "Draw a scientist at work". Further pilot testing of the new instructions resulted in illustrations with much more detail. They determined that reliability was enhanced by using trained graduate students to administer the DAST in a uniform way to all participants. Finson et al's (1995) rubric for scoring the DAST, the DAST-C, also strengthened the reliability of data collected using the instrument.

Barman (1999) established population and ecological validity for the DAST across elementary grade students in the United States. Using the DAST-C, he compared data from over 1,500 students in kindergarten through eighth grade in the United States. His findings aligned with those of earlier studies (Chambers, 1983; Finson et al, 1995; Huber & Burton, 1995; Schibeci & Sorensen, 1999).

The DAST-C was employed to study diverse populations in a study with 191 eighth grade students (Finson, 2001). Finson's sample included 30 Caucasian, 67 Native

American, and 93 African American students. His analyses revealed no significant differences between the illustrations of the different racial subgroups. His study demonstrated the utility of the DAST-C for populations other than middle class Caucasian students.

Projective Instruments and Interest in Science

Some researchers argue that students' perceptions of scientists are somehow connected with their attitudes and abilities in science (Finson, 2002). Sumrall's (1995) data revealed the greatest number of "self-image drawings" of scientists was generated by white males. He asserted self-image drawings could be due to an "internal locus of control" evident in white males (1995, p. 89). Conversely, Barman (1999) purported the lack of drawings depicting women or ethnic diversity may suggest that women and minorities see science careers as something others choose.

O'Brien, Kopala, and Martinez-Pons (1999) claimed that the low representation of minority groups in science fields may be due to "deficits in ethnic identity" (p. 231). They asserted that "deficits in ethnic identity" have a negative impact on "self-perceived academic skills as well as career and educational goals" (p. 231). Their study involved 415 eleventh and twelfth grade students of diverse ethnicities and lower to middle SES levels. Data were obtained on ethnic identity, self-efficacy, and occupational goals. Their findings supported that ethnic identity is a predictor of science and mathematics self-efficacy, which in turn predicts career interest in science. Theses findings highlight the need to develop curricula that present diverse images of environmental scientists so that students of different ethnicities and genders may better identify with the field.

Buldu (2006) concluded that the link between "children's perceptions of scientists and their interest in science-related careers was, in some part, demonstrated throughout the study" (p. 129). He based his assertion on statements students made during interviews about their drawings. According to eight of the participants in his study, their pictures represented the scientist they wanted to be or a scientist they knew personally. Conversely, Buldu (2006) claimed that several students stated they would not want to be scientists because scientists "never have fun" (p. 129).

Zledin and Pajares (2000) interviewed women with successful careers in the fields of math, science, and technology to determine what factors influenced their academic self-perceptions and their career choices. An analysis of these data showed that "verbal persuasions and vicarious experiences were critical sources of the women's self-efficacy beliefs" (2000, p. 215). Their findings further revealed that it was also important for the women to know that "others believed in them" (2000, p. 238).

The power of the beliefs of others to influence the self-efficacy of women and minorities in science warrants further consideration when designing curriculum and classroom practices (Andre, Whigham, Hendrickson, & Chambers, 1999; Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Britner & Pajares, 2006; Zeldin, Britner, & Pajares, 2008). The continued perceptions by the majority of males that science is a masculine field should be addressed to better support and encourage females and ethnic minorities to pursue science. As Finson argued (2002), the failure to identify and use students' stereotypical images to inform curriculum and instruction may "lead to increased erosion in the number of scientists in the workforce" (p. 343).

The Use of Projective Instruments in Environmental Science Education

Chambers' (1983) study demonstrated that students rarely drew pictures of scientists outdoors and only 2% of students identified scientists as working on pollution or another environmental issue. Since that time, numerous studies in the field of EE have employed projective instruments to assess students' knowledge and perceptions (Alerby, 2000; Bowker, 2007; Dove et al, 1999; Shepardson, 2005; Shepardson et al, 2007).

Dove et al (1999) studied 306 students aged nine to eleven from the United Kingdom. The researchers asked students to draw a river and provided students with ten to fifteen minutes to complete the task. Follow-up interviews were conducted with fifty participants to ensure researchers were accurately measuring students' levels of understanding. In 2000, Alerby expanded the age group employed to include 109 Swedish students from seven to sixteen years of age. The researchers asked the participants, "What do you think about when you hear the word environment?" (Alerby, 2000, p. 210). They were asked to draw what came to mind when they heard the question. The researchers asserted that because of the way the question was framed, the illustrations represented what the students were actually thinking at the time. Data from their study revealed that students tended to align with either the theme of "good world" and drew pleasant pictures or "bad world" and drew pictures featuring pollution or devastation (2000, p. 213).

Shepardson (2005) used drawings from students in seventh through ninth grade to assess how well students understood environments. He further asked students to explain their illustrations to confirm his analyses of the drawings. Shepardson et al (2007) and Bowker (2007) also used students' drawings to measure understanding and reveal students' misconceptions about the environment. Each study employed interviews to better understand students' pictures.

These studies exemplify how environmental educators have used projective instruments to probe students' conceptions about the environment. In 2003, Thomas and Hairston used a projective instrument, adapted from the DAST, to measure students' perceptions of environmental scientists.

Research on Students' Perceptions of Environmental Scientists

More recently, researchers have begun to employ projective instruments to examine students' perceptions of environmental scientists. Thomas and Hairston (2003) identified adolescents' perceptions of environmental scientists using a sample of 757 (388 females, 369 males) junior high and high school students from a rural school district in the United States. Their instrument, the Draw-an-Environmental-Scientist Test (DAEST) was modeled after Chambers' DAST. Students were asked to draw an environmental scientist, describe the individual, and what they were doing in the picture.

The rubric contained three parts. Part one incorporated the seven stereotypical indicators of scientists identified by Chambers (1983): lab coat; eyeglasses; facial hair; symbols of research (such as lab equipment); symbols of knowledge (such as notebooks or file cabinets); technology, and relevant captions. Part two of the rubric included alternative images of scientists such as gender, ethnicity, and age. The final part of the rubric incorporated additional images of environmental scientists not included in parts one and two of the rubric. These encompassed the location and nature of their work and how they felt about their work. In all, nineteen indicators appeared on the rubric and one point was scored for each of the nineteen depicted in a student's drawing. If multiple pictures for an indicator were evident, only one point was awarded for that category. Using this checklist and three independent raters, an inter-rater reliability score of .95 was obtained in Thomas and Hairston's study.

Noticeably absent from Thomas and Hairston's (2003) description of their participants was a discussion of the ethnicities of their participants. Respondents in their study overwhelmingly drew Caucasian scientists yet these data are hard to interpret in light of the fact that the ethnic distribution of the students was not given.

Aligned with trends in research on scientists in general, only 11% of the participants in Thomas and Hairston's (2003) study drew a female environmental scientist though the study sample had the same number of males and females. Additionally, their study (2003) demonstrated that junior high and high school students had developed perceptions about environmental scientists through personal experiences and affiliations. As these data demonstrated, students' perceptions of environmental scientists do not necessarily include images that "look like the student". Fifty percent of the sample included females but only 11% of the drawings were of female environmental scientists. These findings are significant if curriculum designers and teachers are to challenge and change the inaccurate perceptions of many students about the images and duties of environmental scientists.

Arguably a relatively small percentage of these students are likely to be scientists or environmental scientists but they all will be citizens of the environment. Their views on stewardship are essential in informing instructional content and practices to equip them with 21st century skills for environmentally responsible behaviors. Every generation has relied on environmental stewards to educate and advocate for environmental protection.

With this generation of students possibly being the first to grow up without a familial attachment to land, our nation is at risk of not having a new generation of stewards to continue the work of earlier environmental leaders. EE curriculum and instruction that are thoughtfully designed around students' perceptions and experiences could mitigate the possible decrease in stewards of the future.

Summary and Problem Statement

Trends in students' views of scientists have remained relatively consistent across the more than fifty years of studies reviewed. The majority of students still tend to depict a scientist as a Caucasian male, though some changes in percentages may indicate the positive influence of cultural role expectations or science education reform. While women and minorities continue to remain underrepresented in science fields, it is essential to recognize the cultural norms in 1957 when this field of inquiry began. At that time, women were not asked what kind of scientist they might like to become. Instead, they were asked what type of scientist they would like to marry. The fact that increases in alternative images of scientists in students' drawings are evident (females and diverse ethnicities) is encouraging. Still, there is much work to be done in science if women and minorities are to obtain the same level of academic and occupational achievement as males.

Environmental science is receiving a growing amount of attention from the public and politicians due to growing environmental concerns. As EE becomes more prevalent in public schools, it is incumbent upon educators and curriculum developers to create and foster an inclusive environment where all genders and ethnicities can see themselves reflected in the field. It is important to address the way women and minorities perceive their abilities and roles in environmental science. Yet, it is equally important to challenge the stereotypes that still exist among many male students.

While numerous studies examined elementary students views of scientists (e.g., Chambers, 1983; Schibechi & Sorensen, 1983; Thomas & Hairston, 2007) and elementary students' perceptions of their environments (e.g., Dove et al, 1999; Shepardson, 2005; Shepardson et al, 2007; Yilmaz, 2004), a review of the professional literature did not reveal studies on elementary students' views of environmental scientists.

Such studies have been conducted with junior high, high school, pre-service and in-service teachers. Since research on addressing students' inaccurate perceptions of scientists suggests early interventions, it would seem that elementary school is the ideal place to challenge inaccurate views of environmental scientists. In order to do this, curricula must be developed in response to identified perceptions. Because elementary students often lack the literacy skills necessary to complete other instruments, administration of the DAEST to elementary students is in order. Locally and globally societies must deal with environmental issues. To prepare students for the issues they will face as adults, they must see a place for themselves in protecting the environment, either as environmental scientists or environmental stewards.

Overview of Study

Using a non-experimental mixed-methods design, the study examined illustrations of environmental scientists produced by 320 urban, predominantly African American elementary students from a public school system in a mid-Atlantic state. These data were collected as part of a larger watershed study with which the researcher was employed.

Pilot testing of the instruments was conducted in Fall 2009. Data collection occurred in Fall 2009 and Spring 2010. Semi-structured interviews were conducted with 15 purposefully selected students using typical and rich case sampling. (Criteria for identifying typical and rich cases are discussed in depth in Chapter IV). Findings from this research will be used to guide further research and inform curriculum development in the area of elementary environmental science. The research was guided by the following research questions:

1. How do students view environmental scientists?
2. How do students view environmental caretakers?
3. How do students view their roles regarding environmental responsibility?
4. Do male and female students' views of environmental scientists, environmental caretakers, and environmentally responsible behaviors differ?

CHAPTER III

METHODOLOGY

This chapter provides a description of the methods for this research. Demographic data on research participants, as well as, sample selection and sample size are provided. A discussion of the instruments used and the evolution of the researcher created Draw-an-Environmental-Caretaker Test (DAECT) are presented. The chapter further provides a discussion of data analysis techniques utilized.

Research Design

The study employed a non-experimental mixed-methods design (Creswell, 2009). The research took place primarily at one elementary school in an urban public school district because all fifth graders in the district rotated through this school for an EE unit. The follow-up interviews, however, occurred at five different elementary schools within the district.

The school district is situated in the mid-Atlantic region of the United States. Access to the site was obtained via a grant partnership between the University and the school district. As part of the larger grant, University Institutional Review Board approval was obtained for this research (Appendices A & B).

Participants

Participants in this research included 320 fifth grade urban elementary students. Participants were selected using cluster sampling. (Pre-existing classes from each of the fourteen schools in the district rotated through the research site to participate in an environmentally based science unit). Approximately one-third of all fifth graders (~950) in the school district of study were included in the data collection process. Demographics of students were representative of those of the overall school district (see Table 1). The majority of the students were African American (71.6%) with the remainder consisting of mostly Caucasian (25.6%) students. Males outnumbered females in the sample 54% (n =173) to 46% (n = 147). Students represented a diverse range of abilities because all fifth grade students in the district were required to rotate through this school for this environmentally based science unit.

While the district's students come from diverse socioeconomic backgrounds, a large portion of the district's students are economically disadvantaged. The district contains fourteen elementary schools with twelve of those designated as Title I schools (87.5%) The Elementary and Secondary Education Act of 1965 specified that additional money be provided to schools identified as Title I. These funds are aimed at improving the education of disadvantaged, at-risk students. To be named a Title I school, the school must provide evidence of a poverty index of 75% or greater. The index is obtained by dividing the number of students eligible for free or reduced lunches by the total student population. The sample for the research included five elementary schools, four of which were Title I (83.3%).

Slightly more than three hundred twenty students were enrolled in the classes in the study. All students who attended and obtained parental permission to participate in the research were administered the DAEST and the DAECT (N = 320). Semi-structured interviews were conducted with 15 students, three from each school included in this research. Purposeful sampling was employed to identify individuals for semi-structured interviews based on richness of articulation, which was defined in terms of quality of response (either drawing, writing, or both). Interviewees were selected to represent typical and rich case responses. Criteria for identifying typical and rich cases will be discussed further in Chapter IV.

Table 1

Demographic Data for District and Sample

Variable	District	Sample
Title I Elementary Schools	12/ 14 (87.5%)	4/5 (83.3%)
Ethnicities:		
African American	78.3%	71.6%
Caucasian	18.9%	25.6%
Hispanic, Asian, and Native American	2.8%	2.8%
Gender Distribution:		
Males	50.0%	54.0%
Females	50.0%	46.0%
Total # of Fifth Graders	Approximately 950	320

Note: District demographics were obtained from the National Center for Educational Statistics website.

Instrumentation

Three instruments were used in this study: the Draw-an-Environmental-Scientist Test (DAEST), the Draw-an-Environmental-Caretaker Test (DAECT), and Semi-Structured Interviews (SSI) (Table 2). The origin, contents, and measures of validity and reliability for each instrument are presented in the next section.

Table 2

Instruments Employed

Instrument	Description	Data Analysis
DAEST (Appendix D)	Student generated drawings/descriptions	1. Coding of responses using the DAEST rubric (Table 3). 2. Frequencies for stereotypical indicators. 3. Descriptive statistics by student gender. 4. Chi-square analysis and follow-up tests for indicators by student gender.
DAECT (Appendix E)	Student generated drawings/descriptions	1. Coding of responses using the DAEST rubric (Table 5). 2. Frequencies for stereotypical indicators. 3. Descriptive statistics by student gender. 4. Chi-square analysis and follow-up tests for indicators by student gender. 5. 4 R's (reduce, reuse, recycle, respond) for frequencies and trends (Table 6).
SSI (Appendix G)	Narrative data of transcribed audio recordings	1. Transcribed and coded data 2. Conducted pattern analysis 3. Identified themes

Draw-an-Environmental-Scientist Test (DAEST)

The DAEST, created by Thomas and Hairston (2003), was adapted from Chambers' (1983) Draw-a-Scientist Test (DAST). Using pilot data and Finson et al's (1995) DAST rubric, Thomas and Hairston (2003) created the DAEST scoring rubric (Table 3). In Thomas and Hairston's (2003) study, three independent raters scored the same set of pictures using their rubric. An inter-rater reliability measure of .95 was obtained. As described in Chapter II, the DAEST yields scores related to the standard images and alternative images of environmental scientists as measured on the DAEST rubric (Thomas & Hairston, 2003).

Table 3

Draw-an-Environmental-Scientist Rubric

Indicators	Evident
STANDARD IMAGE:	
1. Lab coat	________
2. Eyeglasses	________
3. Facial growth of hair	________
4. Symbols of research	________
5. Symbols of knowledge	________
6. Technology	________
7. Relevant captions	________
ALTERNATIVE IMAGES	
8. Gender:	________
a. Male	
b. Female	
c. Gender neutral	
9. Ethnic background:	________
a. Caucasian	
b. African American	
c. Asian	
d. Ethnic neutral	
10. Age:	________
a. Middle-aged	
b. Elderly scientist	
11. Indications of danger	________
12. Presence of light bulbs	________
13. Mythic images	________
14. Indicators of secrecy	________
ADDITIONAL IMAGES OF AN ENVIRONMENTAL SCIENTIST:	
15. Savior image	________

16. Natural setting(s) of work: __________
    a. Water environments
    b. Mountains
    c. Trees/forest
    d. Soil/dirt
    e. Wildlife
    f. Urban/city
17. Nature of scientific work: __________
    a. Observing
    b. Measuring
    c. Testing samples with scientific equipment
    d. Collecting data
    e. Experimenting
    f. Reporting
    g. Work cooperatively
18. Type of scientist: __________
    a. Wildlife biologist
    b. Aquatic biologist
    c. Forester
19. Emotions: __________
    a. Joy and hope
    b. Sadness

TOTAL POSSIBLE SCORE: 19 __________

Score of:

Standard images: 7
Alternative images: 7
Additional images 5

(Thomas and Hairston, 2003)

Evolution Of The Draw-an-Environmental-Caretaker Test (DAECT)

This researcher created instrument was guided by a review of the professional literature. The researcher sought to examine elementary students' views of the characteristics and roles of environmental caretakers. The information could shed light on whether or not elementary students identify with environmental caretakers and what they perceive their roles as environmental caretakers to be. It was of interest to the researcher to see if replacing the word “scientist” with the phrase “taking care of” resulted in drawings that were more representative of the students.

Modeled after the DAEST, the DAECT was initially created using the word “steward”. This is the language that appears in the professional literature and in the district’s assessments. The instrument for the first pilot instructed students to draw an environmental steward. Students were also asked to explain what the steward was doing in their picture. Data from the pilot revealed that the majority of students (81.5%) did not understand the word “steward”. Twenty-two of twenty-seven students left the paper blank, drew a question mark, or wrote, “I don’t know”. In the five completed instruments, students drew: people with plants (2), people picking up trash (1), a boat (1), and a bear (1).

The researcher examined alternate language that could be used such as “responsible” and “care”. A review of the professional literature led the researcher to use “taking care of the environment” because it implied action. It was discerned from the literature that one could be responsible for something without actually taking action. For example, a student might be responsible for his homework. That does not mean that he will necessarily do it. The researcher chose the wording “taking care of” to emphasize behaviors.

The revised instrument required students to draw a picture of someone taking care of the environment. The students were also asked to write a sentence or two describing what the person in their picture was doing. The instrument was piloted with 45 students similar to those in the study’s sample. The pilot sample represented 14% of the study’s sample.

Students were provided with ten minutes to complete their drawings. Most students in the pilot group finished before the end of the allotted time.

Piloted drawings were scored using the DAEST rubric. Responses from the pilot data are presented in Table 4. All indicators present in students' drawings were recorded. Some students included multiple representations of an indicator while others included none. For this reason, percentages will not necessarily equal 100%.

Table 4

Draw-an-Environmental-Caretaker Test Pilot Data

Indicator	Percentage
STANDARD IMAGE:	
1. Lab coat	0%
2. Eyeglasses	0%
3. Facial growth of hair	0%
4. Symbols of research	0%
5. Symbols of knowledge	0%
6. Technology	0%
7. Relevant captions	0%
ALTERNATIVE IMAGES	
8. Gender:	
a. Male	22.2%
b. Female	28.9%
c. Gender neutral	42.2%
9. Ethnicity	not obtained
10. Age:	
Child	26.7%
Adult	6.7%
Unclear	66.7%
11. Indications of danger	0%
12. Presence of light bulbs	0%
13. Mythic images	0%
14. Indicators of secrecy	0%

ADDITIONAL IMAGES OF AN ENVIRONMENTAL SCIENTIST:	
15. Savior image	2.2%
16. Natural setting(s) of work:	
a. Water environments	6.7%
b. Mountains	0%
c. Trees/forest	31.1%
d. Soil/dirt	33.3%
e. Wildlife	11.1%
f. Urban/city	4.4%
17. Nature of caretakers work:	
a. planting	2.2%
b. watering plants	13.3%
c. picking up trash:	
from land	51.8%
from water	4.4%
d. recycling	62.2%
e. educating/advocating	2.2%
18. Emotions:	
a. Joy and hope (Smiling)	68.0%
b. Sadness	0

Findings from the pilot informed the adaptation of the DAEST rubric to create the DAECT rubric (Table 5). Standard images of scientists were removed because 0% of the pilot sample (n = 45) incorporated them in their drawings. Additions to the rubric were also made based on pilot data. For example, the researcher noted that many students drew a single individual while others drew two or more individuals. Some of the groups drawn were shown working collaboratively while others were depicted as adversaries. These findings were incorporated into the scoring rubric for the research (Table 5).

This rubric was used to analyze study data from DAECT drawings. All indicators present in each picture were counted to provide frequencies for each. To provide a measure of reliability for the DAECT rubric, a doctoral student with training in qualitative methods was recruited to independently code 25 student drawings. The researcher and the independent reviewer obtained a minimum acceptable inter-rater reliability measure of .85.

Content in students' drawings not included in the rubric was noted and recorded during the analysis phase. These data were examined for interesting trends and possible future revisions of the rubric. These data were also used for triangulation of findings across sources.

Table 5

Draw-an-Environmental-Caretaker Rubric

Indicator	Evident
1. Gender:	
Male	________
Female	
Not Evident	
2. Individual	________
3. References to self	________
4. Group (two or more individuals):	
Number of individuals	________
Group working together	________
Group working against each other	________
5. Age:	
Child	________
Adult	________
Unclear	________
6. Savior reference	________
7. Setting:	
Unclear	________
Water environment	________
Mountains	________

Trees/forest	________
Soil/grass/plants	________
Urban/houses	________
Park	________
8. Wildlife:	
Birds	________
Other	________
9. Actions:	
Planting	________
Watering plants	________
Picking up trash:	
From land	________
From water	________
Recycling	________
Helping animals	________
Educating/Advocating	________
10. Displayed Emotions:	
Smiling	________
Frowning	________

Semi-Structured Interviews (SSI)

Semi-structured interviews allowed for further exploration of students' prior drawings and overall perceptions of environmental caretakers. Nine open-ended questions with probes were asked of student participants. Questions centered around three main areas. The three areas were:

1. Who takes care of the environment? (Identity)
2. How do they take care of the environment? (Role/Function)
3. Where do they do their work? (Location)

Questions were developed around these three themes after reviewing both the professional literature and student responses from the pilot. To add to the content validity of the instrument, a blueprint was utilized for question construction (Appendix F). Questions also underwent multiple expert reviews and revisions. In addition, pilot testing of the SSI protocol occurred prior to the study.

The SSI protocol contained three open-ended questions for each of the three topics: Identity, role, and location (Appendix G). Follow-up probes were utilized and were responsive to the evolution of the research and data collection process.

Procedure

Institutional Review Board (IRB) approval for the research was obtained under the larger grant funded research (Appendix A). As part of the larger funded study between the University and public school district, parental consent forms were obtained. The project staff hired a point of contact person, well known by principals, parents, and students in the district. This individual distributed and collected parental consent forms for the researcher.

Once committee approval for the study was obtained, the researcher began administration of the instruments with students in the five schools. These data were collected between December 2009 and March of 2010 (Appendix I). Classes rotated through the four-day program throughout the school year. Each rotation included two classes enabling the researcher to alternate the order in which the instruments were administered. Students in classroom A were given the DAEST first while students in classroom B completed the DAECT first to counterbalance the order of instrument administration (McMillan, 2008).

To maintain the confidentiality of students, call names they chose for the unit were used instead of students' real names. Students generally used animal names such as shark or stingray. The teacher provided the researcher with a master list of students' names and call names. This information was kept in a secure location and only used by the researcher for arranging semi-structured interviews and data analysis. Once the researcher obtained the necessary information from the master lists, they were destroyed.

Data collection occurred in rooms A and B simultaneously. The DAEST and DAECT were administered by the same teachers throughout the study. The teachers were trained in data collection and read from a written protocol (Appendix C). Teachers instructed students to write their call names on their papers. They were reminded not to use their real names. Teachers read the instructions aloud for students and students were provided ten minutes to complete each drawing. Students were instructed that there were no right or wrong answers and researchers just wanted to know what they thought. Once the time period for each instrument was complete, the teacher collected that instrument before distributing the next one. To ensure uniformity in test administration, the researcher observed the first two rounds of data collection in each of the two rooms.

Candidates for semi-structured interviews were identified from students' illustrations based on richness of responses and interviewed within three weeks of completing the DAEST and the DAECT. Again, the individual hired by the grant to obtain parental consent worked with the researcher to arrange times for the semi-structured interviews. A small financial incentive ($10 gift card) was provided to students who participated to compensate them for their time. Dates for interviews were arranged and interviewee names were forwarded to the principal to ensure parental consent had been obtained and students' schedules could accommodate interviews.

For each interview, I met with the principal and the principal arranged for the students to meet me (one at a time) in the library, counselor's office, or principal's conference room. The principal introduced the children to me. I then asked the students where they would like to sit. Once the students and I were seated, the purpose of the visit was explained to the students.

All students were assured confidentiality and were told they could choose to end the interview at any time. I informed students I would be asking about 9 questions and the interview would last about 15 minutes. The students were also told this was not a Standards of Learning test and there were no right or wrong answers. I assured students I was interested in what they thought. Most students smiled when I said this was not a test with right or wrong answers. Students noticeably relaxed more at this point in the interview process. Upon receiving student agreement, I provided students with copies of their environmental scientist and environmental caretaker drawings created earlier. The students were given several minutes to review the drawings to refresh their memories.

At the beginning of each interview, I asked students if they agreed to allow me to record our conversation. Verbal consent was obtained on the recorder for all participants. (Written parental consent and student assent had been obtained earlier for all participants by the project liaison). Interviews ranged in duration from about 8 minutes to 17 minutes. The mean length of interviews was approximately 11 minutes. Once the interviews were completed, the researcher thanked the students and asked them if they had any questions. If so, the questions were addressed. Once their questions were answered, or if there were no questions, the researcher again thanked the students and allowed them to return to their classrooms.

Data Analysis

Draw-an-Environmental-Scientist Test

Descriptive statistics provided an overview of stereotypical indicators in students' drawings (Figure 1). Inferential statistics included the use of Chi-Square analyses on stereotypical indicators used by male and female students. The traditional alpha level set for comparisons was .05.

Students' written descriptions of their illustrations served two purposes. First, they were used to clarify interpretation of indicators present in the picture. Secondly, they were coded and themes that emerged were reported.

Draw-an-Environmental-Caretaker Test

Descriptive statistics provided an overview of indicators in students' drawings. Quantitative analyses included the use of Chi-Square analyses on stereotypical indicators between male and female students. Again, the alpha level was set at .05 for rejecting the null hypothesis. Frequencies for DAEST and DAECT data were compared for similarities and differences. To determine the impact of the order of instrument administration, Mann-Whitney tests of independent samples were conducted on responses from students in rooms A and B.

Data analyses also included an examination of environmentally responsible behaviors. This analysis arose after examining pilot data. Not initially included in the original research design, this was added in response to the data that emerged. The researcher observed that the majority of students depicted individuals either recycling or restoring a damaged environment. If the majority of students identify corrective actions (recycle, restore) and not preventative actions (reduce, reuse), these findings are worth closer examination and may have implications for EE curricula and instruction (Table 6).

A review of the literature revealed Meeks, Keit, and Page (2003) categorized environmental behaviors into 4 groups: reduce, reuse, recycle, and respond. They purported that the fourth R (respond) emphasized taking personal responsibility for the environment. Throughout the literature the terms "pro-environmental" and "environmentally responsible" behaviors appeared. An examination of studies in this area (Gough, 2002; Jensen, 2002; Kollmuss & Agyeman, 2002) guided the researcher to use the phrase "environmentally responsible" behaviors. Environmentally responsible behaviors and stewardship actions are aligned in that they take into account the interconnectedness of all global citizens.

The literature revealed that the term "pro-environmental" is problematic in that it is relative. If a "pro-" of something exists, then a "con-" is likely to exist as well. For example, it is pro-environmental for a town to dispose of its computers by sending them elsewhere. Their environment will not be negatively impacted. The location that receives the discarded computers, however, will be negatively impacted if the computers end up in their landfill. Thus, the researchers chose to use the terminology "environmentally responsible behaviors" and not "pro-environmental behaviors" when discussing caretakers' actions.

Table 6

Four R's: Environmentally Responsible Behaviors

Preventative Behaviors	**Corrective Behaviors**
Reduce	Recycle
Reuse	Restore

Semi-Structured Interviews (SSI)

Student interviews were transcribed and coded. Transcriptions were examined for the emergence of patterns and themes (Patton, 2002, p. 453). Themes were identified and supporting evidence from student interviews provided in the form of verbatim quotes.

An independent reviewer was asked to review and code 20% (n =3) of the interview data. The codes from the researcher and independent reviewer were compared and an inter-rater reliability measure obtained. An acceptable inter-rater reliability value of .85 was obtained.

CHAPTER IV

RESULTS

This chapter presents data obtained on students' perceptions of environmental scientists, environmental caretakers, and environmentally responsible behaviors. Data are reported for each of the three instruments employed in this research. All of these data are discussed in Chapter V in the context of the research questions for this study.

The research was guided by the following questions:

1. How do students view environmental scientists?
2. How do students view environmental caretakers?
3. How do students view their roles regarding environmental responsibility?
4. Do male and female students have different perceptions of environmental scientists, environmental caretakers, and environmental responsibility?

Order of Instrument Administration

The two projective instruments used in this research were administered in alternate order to students in rooms A and B each time. Frequencies of indicator use for each group on each instrument were obtained and Mann-Whitney tests for independent samples were conducted. With a set significance level of .05, only one significant difference was identified between group responses based on order of instrument administration. A difference was found in the use of relevant captions by students in the two groups (sig. = .039). Students in the group that drew the environmental scientist last were almost twice as likely to use relevant captions as students who drew the environmental scientist first. (Frequencies by group and Mann-Whitney tests of significance are provided in Appendix I for the DAEST and Appendix J for the DAECT).

Draw-An-Environmental-Scientist Test (DAEST)

Data from both the students' drawings and writings were used collectively to determine the appropriate variable value for each indicator for entry into SPSS. For instance, a picture may have appeared to be gender neutral but the student used a masculine pronoun to refer to their scientist. Thus, the individual in the drawing was categorized as male. When the scientist's gender could not be determined after examining both the illustration and the writing, the scientist's gender was recorded as neutral. Subsequent interviews with selected participants (N = 15) confirmed that the gender coded for the scientist was the gender they intended in their drawing. These data provide evidence that the method employed to determine gender was valid. This same process of reviewing drawings and writing was used to code each indicator in both the DAEST and DAECT rubrics.

Categorization and scoring of indicators was an iterative process that required several refinements of the coding criteria. Once the criteria were finalized and all values had been entered into SPSS, a doctoral student was trained in the use of the criteria for scoring student drawings. After the training, the doctoral student scored a random subsample of the drawings for each instrument. The subsample was 10% (n = 30) of the total sample for each instrument. Variable values for the researcher and fellow doctoral student were compared and inter-rater reliability values determined.

For drawings of environmental scientists, the raters agreed 466 out of 480 times for an inter-rater reliability value of .97. For drawings on environmental caretakers, the scorers agreed 313 out of 330 times for an inter-rater reliability measure of .96. These values reveal a high level of agreement and reflect that criteria used to code the variables were clear.

Frequencies for stereotypical indicators used in students' drawings of environmental scientists are presented in Table 7. "Symbols of research" (such as scientific equipment) was the most commonly used standard image indicator appearing in 45.9% (n = 147) of students' drawings of environmental scientists. Conversely, the use of facial hair as an indicator of an environmental scientist was only evident in 1.9% (n = 6) of student drawings.

Table 7

Students' Use of Indicators on the DAEST

Indicator	Frequency	Percent
STANDARD IMAGES:		
1. Lab coat	32	10.0
2. Eyeglasses	44	13.8
3. Facial hair	6	1.9
4. Symbols of research	147	45.9
5. Symbols of knowledge	40	12.5
6. Symbols of technology	49	15.3
7. Relevant captions	37	11.6
ALTERNATIVE IMAGES:		
8. Gender of scientist:		
Male	125	39.1
Female	65	20.3
Neutral	130	40.6
9. Indications of danger	30	9.4
10. Mythic images	6	1.9
11. Secrecy	1	.3

ADDITIONAL IMAGES OF ENVIRONMENTAL SCIENTISTS:		
12. Savior reference	9	2.8
13. Setting of work:		
Laboratory	142	44.4
Outdoors	111	34.7
Both	3	.9
Not evident	64	20.0
14. Nature of work:		
Observing	65	20.3
Measuring	2	.6
Data collection	34	10.6
Experimenting	114	35.6
Sharing knowledge	10	3.1
Collaborating	6	1.9
Picking up trash/Recycling	37	11.6
Planting/Watering	11	3.4
Caring for animals	6	1.9
Other	4	1.3
Not evident	23	7.2
15. Emotions:		
Happy	208	65.0
Sad	4	1.3
Neutral	108	33.8

A nearly equal number of students drew male (39.1%, n = 125) or gender neutral (40.6%, n = 130) environmental scientists. Female environmental scientists were depicted about half as often as male environmental scientists (20.3%, n = 65).

For additional images of environmental scientists, indications of danger were shown in 30 of 320 drawings (9.4%). Savior references occurred 2.8% (n = 9) of the time. For location of work, more students drew environmental scientists in a lab (44.4%, n = 142). Only .9% (n = 3) of students indicated that environmental scientists' work included time in a lab as well as outdoors.

For the nature of work, most students drew environmental scientists experimenting (35.6%, n = 114), observing (20.3%, n = 65), picking up trash or recycling (11.6%, n =

37), or collecting data (10.6%, n = 34). The least common categories for nature of work were sharing knowledge (3.1%, n = 10) and collaborating or caring for animals (each evident in 1.9% of drawings, n = 6).

Sixty-five percent (n = 208) of student illustrations depicted environmental scientists who were smiling. Slightly more than thirty-three percent (n = 108) drew environmental scientists with no facial expressions. Notably, only 4 out of 320 (1.3%) drawings showed an environmental scientist frowning.

DAEST Student Samples

A student depiction of an environmental scientist is provided in Figure 1. Using the rubric in Table 3, the picture was categorized as: a male, working outdoors, recycling, and smiling. This representation is more typical (compared to percentages in Table 7).

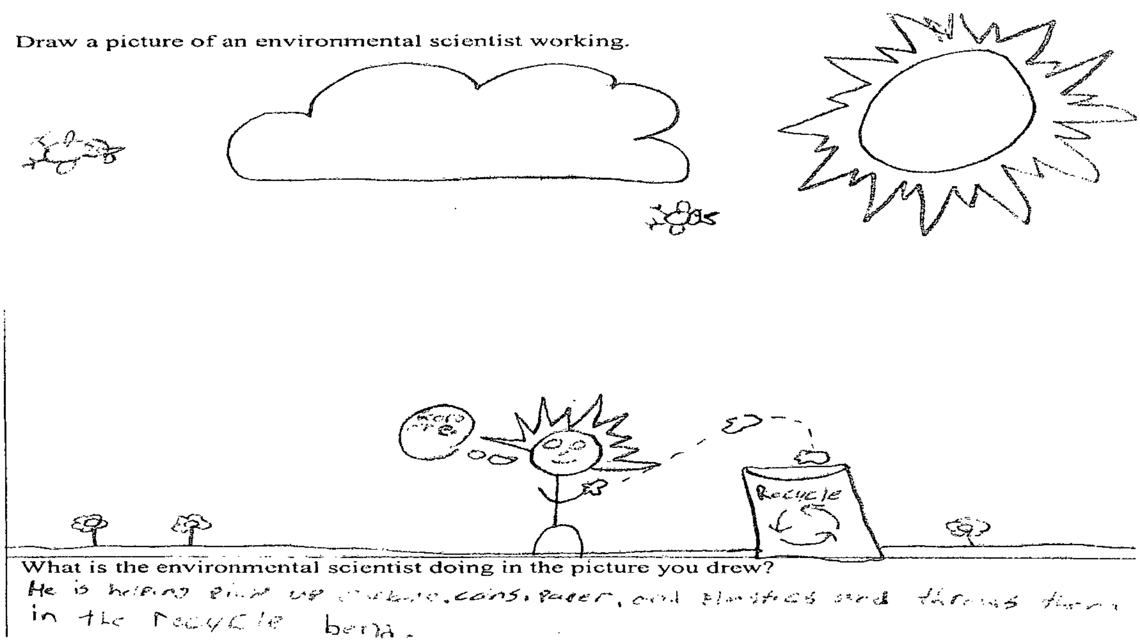


Figure 1. Environmental scientist drawing (Sample 1).

A second student illustration of an environmental scientist is provided in Figure 2. Using the rubric in Table 3, the drawing was coded as: a female, working in a lab, collecting data/searching on computers, with no displayed emotion. The nature of the work (collecting data) only occurred in 10% (n = 32) of student drawings and females occurred in only 20% (n =64) of drawings so these aspects of the illustration could be considered "rich".

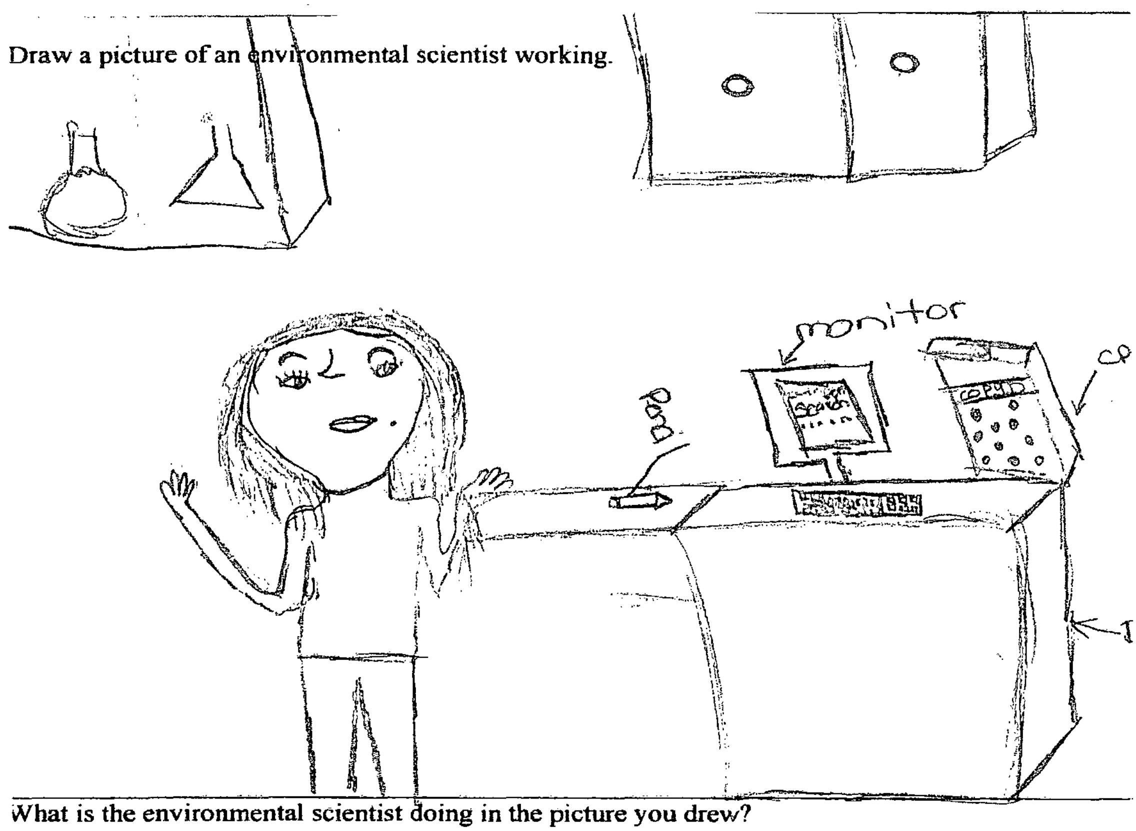


Figure 2. Environmental scientist drawing (Sample 2).

In the third sample of an environmental scientist (Figure 3), the student drew himself rescuing a bird. Pictures with environmental scientists helping animals were not very common (1.9%, n = 6). This illustration would be considered a rich case for this research because it was not typical and reflected a more informed view. The reference to self was also very uncommon for student drawings of environmental scientists.

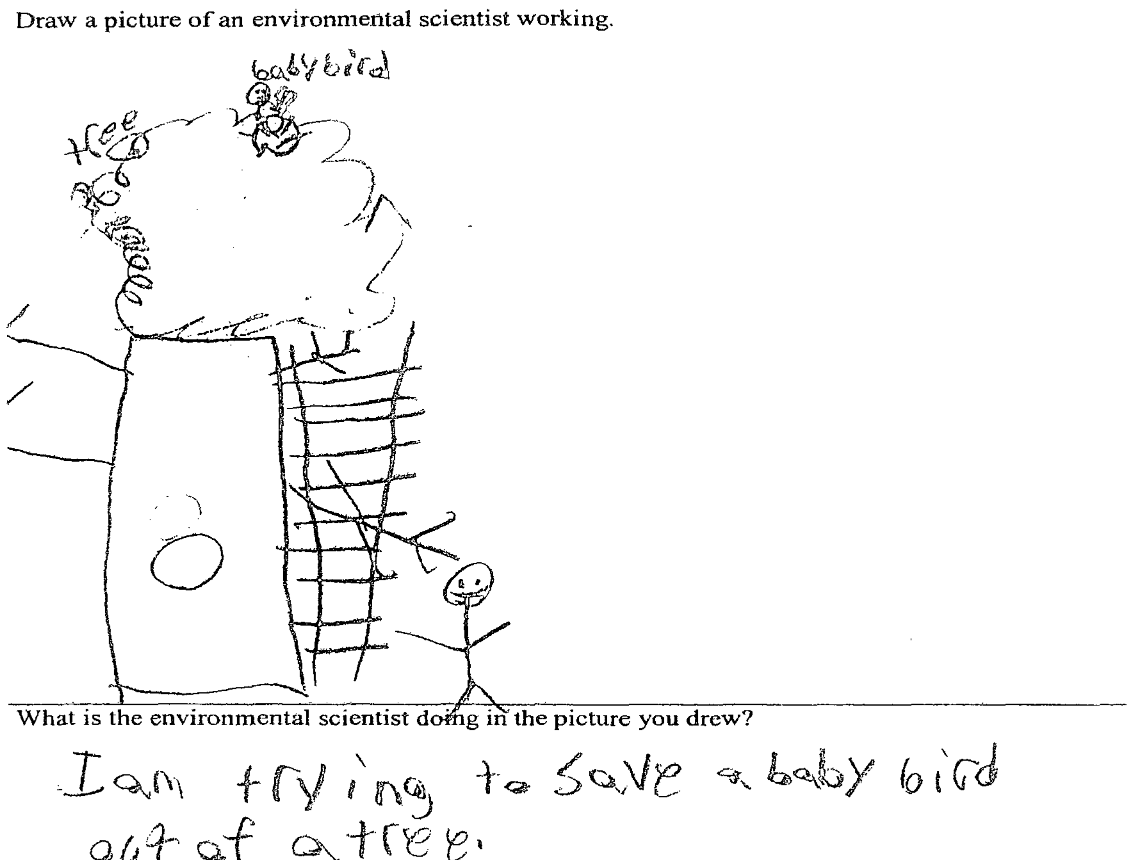


Figure 3. Environmental scientist drawing (Sample 3).

In addition to scoring each picture using the rubric in Table 3, pictures were further examined along the lines of the gender of the student illustrator. Chi-square analyses revealed data obtained deviated from expected values. Follow-up tests were conducted for male students' drawings and then for female students' drawings. Data for drawings created by male students are presented in Table 8.

Indicator Analysis by Student Gender

A Chi-square test statistic of 72.15 (df =2, asymp sig = .000) was obtained for gender of environmental scientists drawn by male students. These values were used to compute an effect size of .21. Table 8 shows that male students were not very likely to draw a female environmental scientist (residual – 52.7). Table 9 presents data on female students' drawings.

Table 8.

Gender of Environmental Scientists Drawn by Male Students

	Observed N	Percent	Expected N	Percent	Residual
Male	84	48.6	57.7	33.3	26.3
Female	5	2.9	57.7	33.3	- 52.7
Neutral	84	48.6	57.7	33.3	26.3

(N =173)

A Chi-square test statistic of 3.96 (df = 2, asymp sig = .138) was obtained for gender of environmental scientists drawn by female students revealing a non-significant deviation of observed data from expected data. This means that the distribution of environmental scientists' gender drawn by female students was not far from the expected values.

Table 9

Gender of Environmental Scientists Drawn by Female Students

	Observed N	Percent	Expected N	Percent	Residual
Male	41	27.9	49	33.3	- 8.0
Female	60	40.8	49	33.3	11.0
Neutral	46	31.3	49	33.3	- 3.0

(N = 147)

Table 10 provides an overview of other environmental scientist indicators that showed noticeable differences in frequency of use by student gender. Chi-square analyses were conducted, as well as follow up tests where significance was found. Chi-square statistics and calculated effect sizes are provided in Table 10.

Table 10

Use of Environmental Scientist Indicators by Student Gender

Indicator	Males			Females		
	%	Sig.	ES	%	Sig.	ES
Symbols of Research	39.3	.005	.05	53.7	.364	NA
Symbols of Technology	13.3	.000	.53	19.0	.000	.38
Relevant Captions	8.1	.000	.70	15.6	.000	.47
Indications of Danger	10.4	.000	.63	7.5	.000	.72
Mythic Images	2.9	.000	.89	1.4	.000	.95
Setting of Work (Lab)	37.6	.000	.12	51.7	.000	.19
Nature of Work		.000	.10		.000	.18

Experimenting	33.5			42.9		
Caring for Animals	2.9			.7		
Not Evident	10.4			3.4		
Emotions		.000	.26		.000	.39
Joy/hope	59.0			72.1		
Sadness/despair	1.2			.7		
None	39.9			27.2		

(N: 320 with males = 173, females = 147). Note: Sig. = Asymp. Significance value from Chi-Square analysis and ES = Effect size.

Table 10 reveals that females were more likely to use symbols of research, symbols of technology, and relevant captions in their drawings. Males were more likely to use indications of danger and mythic images. Females were more likely to draw their environmental scientist in a lab experimenting. Males were twice as likely as females to draw their environmental scientist caring for animals, while females were more likely to draw an environmental scientist smiling while working.

Draw-An-Environmental-Caretaker Test (DAECT)

Students drew environmental caretakers as gender neutral 38.9% (n = 124) of the time, females 30.4% (n = 97) of the time and males 27.6% (n = 88) of the time. Environmental caretakers were depicted working alone about 77% (n = 244) of the time. Groups worked cooperatively in 19.4% (n = 62) of the drawings compared to 3.8% (n = 12) of drawings that showed an adversarial dynamic between group members.

Environmental caretakers were most often drawn in a grassy area with plants (55%, n = 176), an urban area (20%, n = 64) and a water environment (11.3%, n = 36). Students were least likely to show the environmental caretaker indoors, in a forest, or in the mountains. Wildlife was absent in 85% (n = 272) of student drawings. Birds and fish were the most common forms of wildlife found in students' drawings. Rarely did students include more than one type of wildlife in their illustration (2.5%, n = 8).

Seventy-three percent of environmental caretakers were drawn either picking up trash or recycling. Reducing or reusing resources was represented in 4.1% (n = 13) of drawings. Only 2.5% (n = 8) of students drew environmental caretakers sharing knowledge. Environmental caretakers were twice as likely to be drawn smiling than with no facial expression. Only 3% (n = 10) of students drew environmental caretakers who were frowning.

Table 11

Students' Use of Indicators on the DAECT

Indicator	Frequency	Percent
1. Gender(s):		
Male	88	27.6
Female	97	30.4
Gender Neutral	124	38.9
Both Genders	10	3.1
2. Individual	247	77.1
3. References to self	14	4.4
4. Group Number:		
Two Individuals	52	16.3
Three Individuals	6	1.9
Four or More Individuals	12	3.8
5. Group Dynamics		
No interactions evident	244	76.4
Allies	62	19.4
Adversaries	12	3.8
6. Age(s):		
Adult	33	10.4
Child	52	16.3
Age Not Evident	233	73.0
7. Savior reference	9	2.8

8. Setting:		
Water environment	36	11.3
Mountains	1	.3
Forest	6	1.9
Soil/grass/plants/some trees	177	55.5
Urban/neighborhood/park	65	20.4
Indoors	6	1.9
Not evident	28	8.8
9. Wildlife:		
Birds	22	6.9
Fish	10	3.1
Oysters, crabs or starfish	8	2.5
More than one species	8	2.5
None	271	85.0
10. Actions:		
Planting/Watering plants	43	13.5
Picking up trash:		
From land	161	50.5
From water	29	9.1
Recycling	44	13.8
Helping animals	9	2.8
Sharing knowledge	8	2.5
Reducing/reusing resources	13	4.1
Cutting grass	1	.3
Not evident	9	2.8
None of the above	2	.6
11. Displayed Emotions:		
Smiling	199	62.4
Frowning	10	3.1
Neutral	108	33.9
More than one emotion	2	.6

(N = 319; 1 participant did not complete this instrument)

Data from the study's sample align with data from the pilot study. The seven standard images of environmental scientists were not found in the pilot of the environmental caretaker rubric, with one exception. (Only one male student drew an environmental caretaker wearing a lab coat). Similarly, the seven standard images of environmental scientists were not found in the study's data for environmental caretakers. These data support the earlier decision to remove the seven standard images of environmental scientists from the environmental caretaker rubric.

DAECT Student Samples

Figure 4 provides an example of a student's environmental caretaker drawing. This illustration is unique because it shows people taking action to reduce resource use. Reducing resource use only occurred in 3.1% (n = 10) of pictures. Of these ten, nine were drawn by males and one was drawn by a female student. Figure 4 represents the work of the female student. The lack of facial expression occurred in 33.9% (n = 108) of pictures of environmental caretakers.

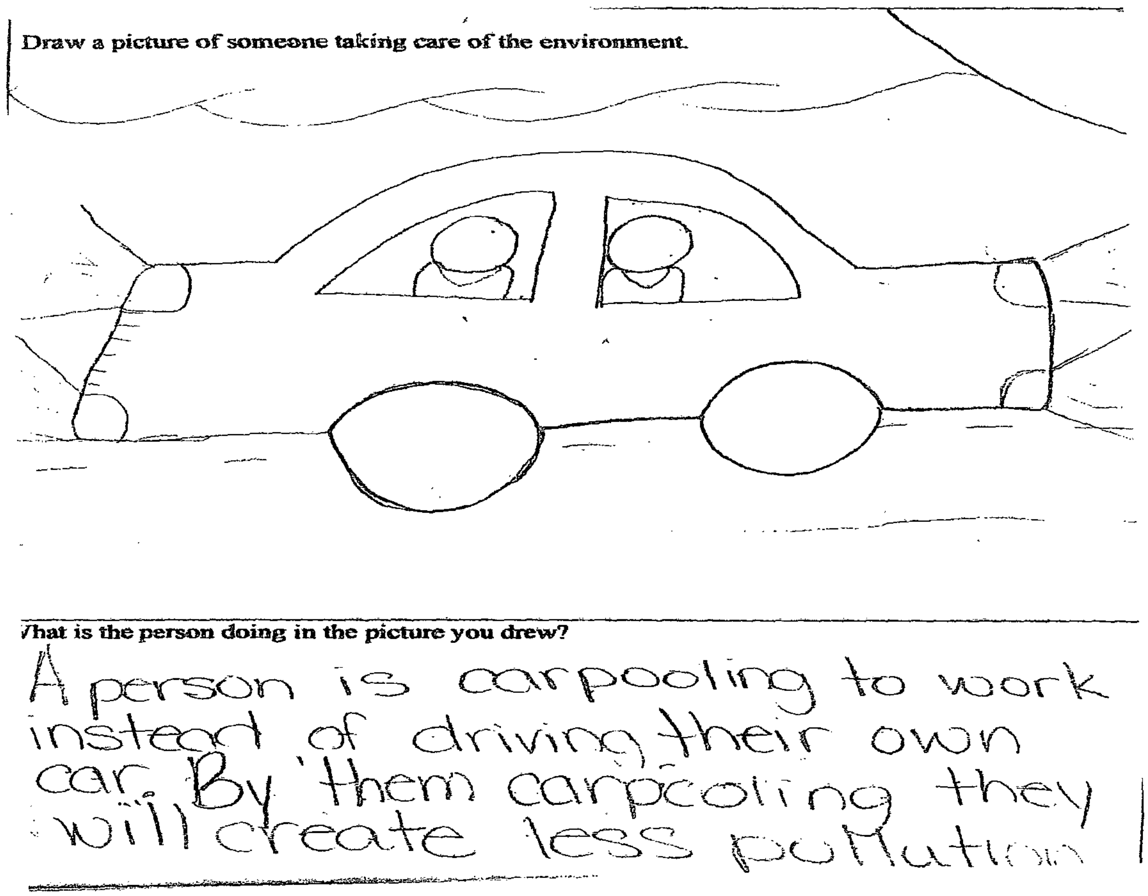


Figure 4. Environmental caretaker drawing (Sample 1).

A second sample of a student's drawing of an environmental caretaker is shown in Figure 5. This illustration includes a female, found in 30.4 % of pictures (n = 97). Female environmental caretakers were drawn more often than males (97 to 88). Only 23.6% (n = 74) of pictures showed multiple individuals. Recycling occurred in 13.8% (n = 44) of illustrations. An urban setting such as a neighborhood or park was evident in 20.4% (n = 65). It is noteworthy that only one-fifth of the urban students drew an environmental caretaker working in an urban setting.

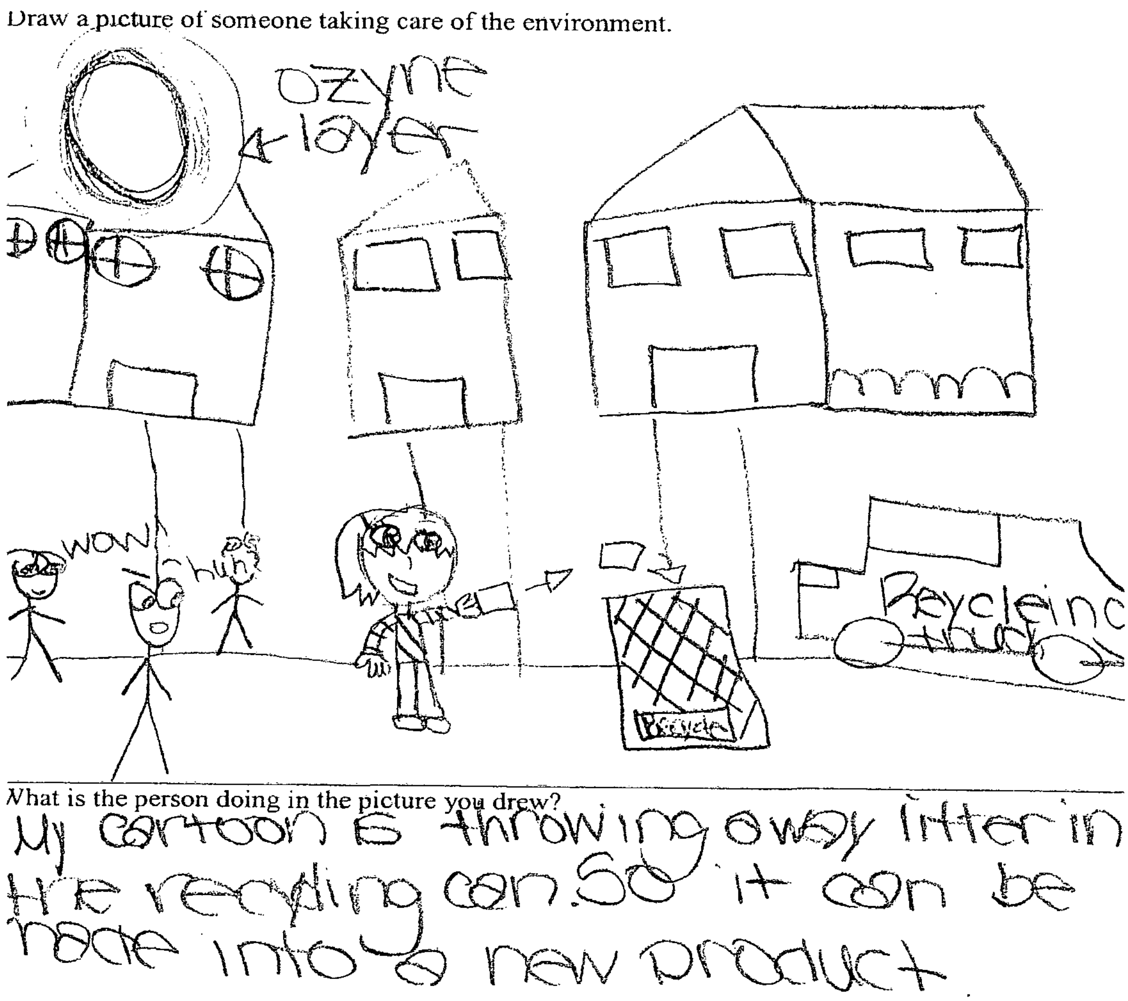


Figure 5. Environmental caretaker drawing (Sample 2).

Figure 6 presents a third sample of a student's drawing of an environmental caretaker. This illustration would be considered a rich case because it involves a water environment. Water habitats were evident in 36 out of 320 pictures (11.3%). Another rich feature of this illustration is the depiction of multiple individuals cleaning the environment. Sixty-two students (19.4%) drew a picture of individuals working together to take care of the environment.

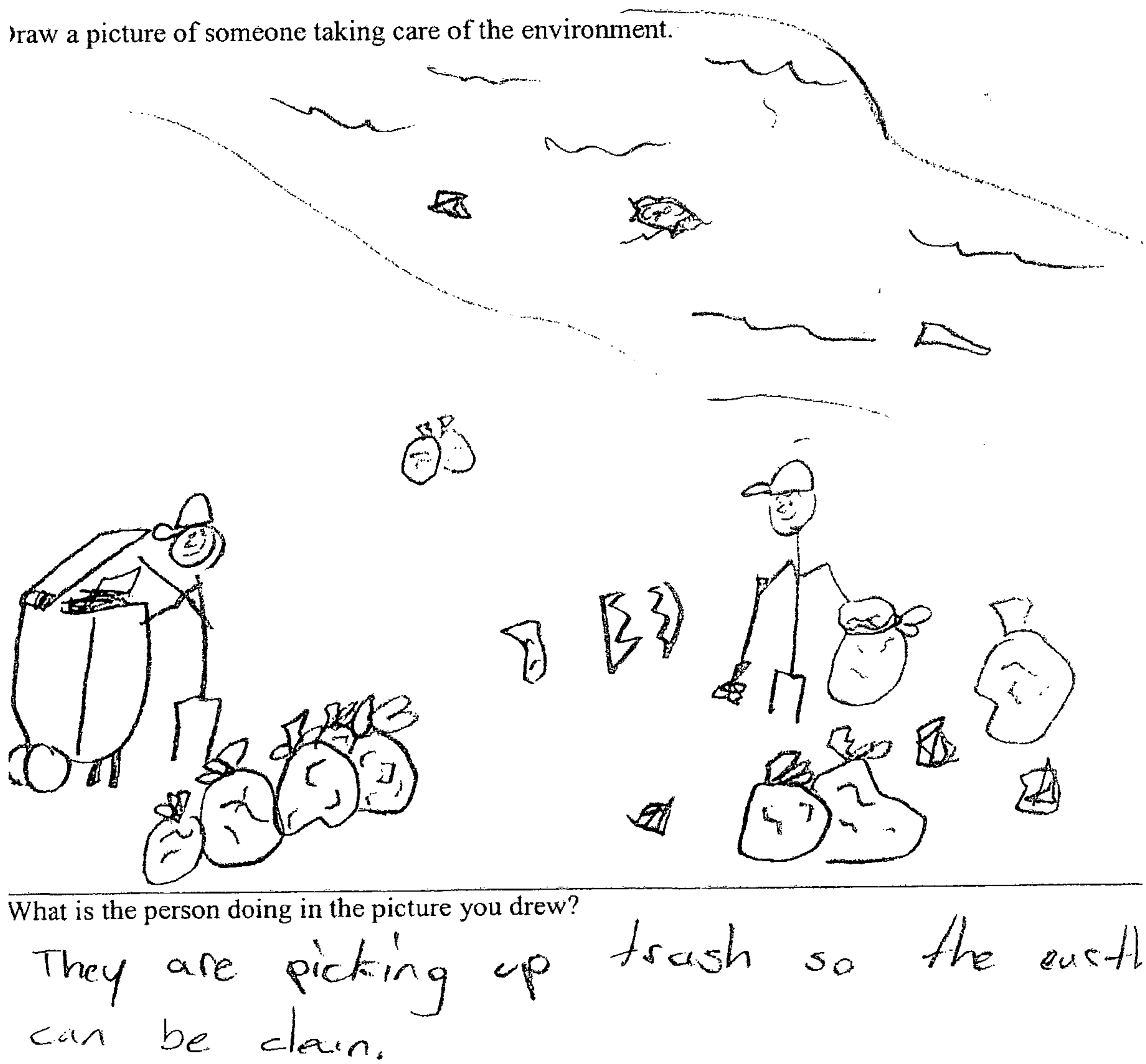


Figure 6. Environmental caretaker drawing (Sample 3).

Indicator Analysis by Student Gender

A Chi-square analysis of environmental caretakers' genders by student gender revealed environmental caretakers' genders deviated from expected values of a random distribution. Data in Table 12 show that male students drew environmental caretakers as males or gender neutral 93% of the time. They drew female environmental caretakers only 5.8% (n =10) of the time and were very unlikely (1.2%, n =2) to include both genders in their illustrations.

Table 12

Gender of Environmental Caretakers Drawn by Male Students

	Observed N	Percent	Expected N	Percent	Residual
Male	79	46.0	43	25	36
Female	10	5.8	43	25	- 33
Neutral	81	47.1	43	25	38
Both Genders	2	1.2	43	25	- 41

(N = 172; 1 male participant did not complete this instrument)

Follow-up tests were conducted revealing a Chi-square test statistic of 128.14 (df =3, asymp. sig. = .000). These values were used to compute an effect size of .25. These analyses show a significant relationship between male students and the gender of environmental caretakers drawn. Similar analyses were conducted for drawings created by female students. These data are presented in Table 13.

Table 13

Gender of Environmental Caretakers Drawn by Female Students

	Observed N	Percent	Expected N	Percent	Residual
Male	9	6.1	36.8	25	- 27.8
Female	87	59.2	36.8	25	50.3
Neutral	43	29.3	36.8	25	6.3
Both Genders	8	5.4	36.8	25	- 28.8

(N = 147)

A Chi-square test statistic of 113.22 (df = 3, asymp sig. = .000) was obtained from follow-up analysis. These data were used to calculate an effect size of .26. These analyses reveal a significant relationship between female students and the gender of the environmental caretaker they drew. Data in Table 14 show that females were twice as likely to draw their caretakers as female (59.2%, n = 87) instead of gender neutral (29.3%, n = 43). Females drew male environmental caretakers 6.1% (n = 9) of the time and 5.4% (n = 8) of the drawings included both genders. Other individual indicators used by students in drawings of environmental caretakers were examined by student gender. Identified differences in the use of the indicators by student gender are presented in the Table 14 and will be further discussed in Chapter V.

Table 14

Use of Environmental Caretaker Indicators by Student Gender

Indicator	Male Students %	Sig.	ES	Female Students %	Sig.	ES
Wildlife in drawing		.000	.74		.000	.57
Birds	5.2			8.8		
Fish	2.9			3.4		
Oysters, crabs, or starfish	.6			4.8		
None	88.4			80.3		
Caretaker actions		.000	.23		.000	.23
Recycling	12.7			15.0		
Helping animals	1.7			4.1		
Sharing knowledge	3.5			1.4		
Reducing/reusing resources	5.2			2.0		
Number of caretakers in drawing		.000	.56		.000	.49
Two	13.3			19.7		
Four or more	5.2			2.0		
Nature of Group Dynamics		.000	.50		.000	.43
Working together	16.8			22.4		
Working against each other	5.2			2.0		

(N = 319 with Males = 172, Females = 147)
Note: Sig. = Asymp. Significance value from Chi-Square analysis and ES = Effect size.

Data in Table 14 show that males did not include wildlife in their environmental caretaker drawings as often as females, though the use of wildlife by both groups was well below expected values from Chi-Square analysis. Female students were more likely to include multiple individuals in their illustrations. Again, the percent of males and females to draw multiple individuals was well below expected values from Chi-Square analysis. Females were more likely to show group members working collaboratively. Male students were more than two times as likely as girls to draw group members working against one another. All of the indicators in Table 14 were found to have significant differences between observed and expected values. Chi-square statistics were used to calculate effect sizes for each indicator. Effect sizes are reported in Table 14.

Four R Actions: Reduce, Reuse, Recycle, and Restore

The pilot study of the environmental caretaker instrument revealed students most often drew caretakers recycling or restoring the environment. Illustrations of caretakers reducing or reusing resources were uncommon. For this reason, illustrations from the study's sample were also analyzed and coded for the four R actions (environmentally responsible behaviors).

Examples of reducing resource use included: drawings of people carpooling, turning off water while they brushed their teeth, and turning off a light switch when they left the room. These types of drawings were not very common (3.1%, $n = 10$). Examples of caretakers reusing resources were even more rare (.9%, $n = 3$) and included a picture of a student refilling a water bottle.

Recycling pictures were identified by the students' use of either the recycling logo or the word "recycle". Examples of restoring included planting trees, picking up trash, or caring for injured animals. Basically, restoring involved correcting or mitigating the impact humans had caused to the environment.

Students' illustrations were coded according to the type of behavior depicted (1-reduce; 2-reuse; 3-recycle; 4-restore). Where no environmental behavior was evident, none of the four R's were recorded for that drawing. These data were entered into SPSS and subsequent analyses conducted. These data are presented in Table 15.

Table 15

Students' Use of the Four R Actions in Illustrations

Action	Frequency by Males	Percent	Frequency by Females	Percent
Reduce	9	5.2	1	.7
Reuse	2	1.2	1	.7
Recycle	29	16.9	40	27.2
Restore	105	61.0	84	57.1

(N = Male, 172; Females, 147)

As with the pilot study, data from this study show that the majority of environmental behaviors (79.3%) shown in students' drawings revolved around restoring the environment (males = 61% and females = 57.1%) or recycling (males = 16.9% and females = 27.2%). These data are graphically represented in Figure 7.

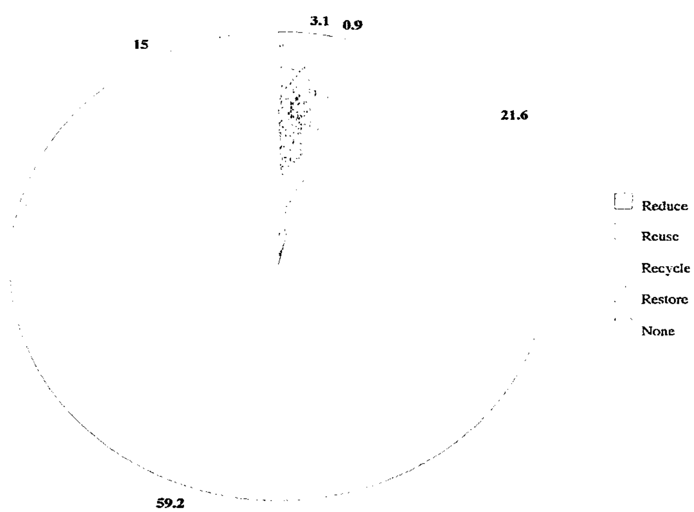


Figure 7. Distribution of 4 R behaviors in students' illustrations.

Semi-Structured Interviews (SSI)

Three students from each of the five participating schools were selected for follow-up semi-structured interviews. Students were selected based on their environmental scientist and environmental caretaker drawings. The researcher selected one-half of the participants as "typical" cases and one-half of the participants as "rich" cases. (Criteria for classification of typical or rich cases are provided in the next section). Additionally, the researcher attempted to interview an equal number of male and female students. Numbers interviewed do not equal a 50-50 representation of genders due to student absences and the use of alternate interviewees.

Typical Versus Rich Cases

Indicators in students' illustrations were compared to percentages in Tables 7 and 11. If all indicators were aligned with the majority of students, a picture was classified as "typical". An illustration was considered "rich" if the picture contained at least one indicator that was found less often in student drawings and reflected either a more informed view or a stereotypical view. Using this process of comparing student drawings to percentages in Tables 7 and 11, both pictures for each interviewee were classified as "rich" or "typical". Eight of the fifteen students interviewed were considered rich cases for at least one of their two illustrations. For instance, pictures of environmental scientists helping animals only occurred in 1.9% (n = 6) of drawings. Such a drawing would be identified as rich. Likewise, environmental caretaker pictures that showed individuals sharing knowledge (such as in teaching or advocating) only occurred in 2.5% (n = 8) of pictures and would be considered "rich" cases. The classifications are presented in Table 17. The rationale for labeling a picture as rich is also provided in Table 17.

This research examined students' responses along gender lines but not along ethnic lines because it was not possible to discern intended ethnicities in students' drawings. Some examination of students' discussion of ethnicities relative to their own race may be possible using interview data and, for this reason, the ethnic identity of interviewees is provided in Table 16.

Table 16

Semi-Structured Interview Participants

Interview Number	Gender	Race	Pseudonym
1	M	AA	Deonte
2	F	AA	Maya
3	F	AA	Merri
4	M	C	Stephen
5	F	C	Kayla
6	M	C	James
7	F	AA	Tiffany
8	M	AA	Larry
9	F	AA	Charity
10	F	C	Emily
11	M	C	William
12	F	C	Rochelle
13	F	AA	Leah
14	F	AA	Brandi
15	M	C	Samuel

(AA = African American, C = Caucasian)

A doctoral student was trained in the identification of typical and rich cases. The student independently examined and classified 20% (n = 3) of students' drawings of environmental scientists and 20% of students' drawings of environmental caretakers. Classifications by the two raters were compared. Raters agreed in 5 out of 6 cases for an acceptable inter-rater reliability score of .83. Discussions of criteria and further clarification of the coding process resulted in 100% agreement on the six cases coded.

Table 17

Classification of Interviewees' Illustrations

Pseudonym	DAEST Classification	DAECT Classification
Deonte	Rich (helping animals)	Rich (wildlife/water habitat)
Maya	Rich (indications of danger)	Rich (water/wildlife/group)
Merri	Typical	Rich (group/reducing use)
Stephen	Typical	Rich (indoors/reusing)
Kayla	Typical	Typical
James	Typical	Rich (reducing resources)
Tiffany	Typical	Typical
Larry	Typical	Typical
Charity	Typical	Typical
Emily	Rich (mythic images/danger)	Typical
William	Rich (sharing knowledge)	Typical
Rochelle	Typical	Typical
Leah	Typical	Typical
Brandi	Typical	Typical
Samuel	Rich (saving a bird)	Rich (reference to self)

Student Responses to Semi-Structured Interview Questions

Question 1: What does an environmental scientist look like?

The majority of male (66.7%, n = 4) and female (55.6%, n = 5) students indicated that an environmental scientist was a young or middle-aged adult. Males (66.7%, n = 4) were more than 20% more likely than female (44.4%, n = 4) students to state that an environmental scientist was male. One-fifth of female students described the environmental scientist as female while none of the males described or drew a female environmental scientist. One-third of all interviewees, males and females, explained that an environmental scientist could be a male or female. For the race of the environmental scientist, no clear majority was evident in student responses. Students provided a diverse range of responses with more than one-half of girls indicating that an environmental scientist could be from any race.

Table 18

Interviewees' Views of An Environmental Scientist

Indicator	Males	Females
Age:		
Child		1/9 (11.1%)
Young/Middle Aged Adult	4/6 (66.7%)	5/9 (55.6%)
Old	1/6 (16.7%)	2/9 (22.2%)
Any age	1/6 (16.7%)	1/9 (11.1%)
Gender:		
Male	4/6 (66.7%)	4/9 (44.4%)
Female		2/9 (22.2%)
Either	2/6 (33.3%)	3/9 (33.3%)
Race:		
Black		

White	1/6 (16.7%)	2/9 (22.2%)
Black or White	1/6 (16.7%)	
Asian	1/6 (16.7%)	1/9 (11.1%)
Italian	1/6 (16.7%)	
Indian		1/9 (11.1%)
Mixed	1/6 (16.7%)	
Any	1/6 (16.7%)	5/9 (55.6%)
Other Standard Images:		
Goggles/glasses		3/9 (33.3%)
Lab coat	1/6 (16.7%)	2/9 (22.2%)
Gloves		1/9 (11.1%)
Name tag	1/6 (16.7%)	
Wears suits	1/6 (16.7%)	
Tall		1/9 (11.1%)

(N = 15)

A greater percentage of female students included other standard images such as goggles and lab coats in their pictures. Charity stated, "He'll have a white lab coat, some goggles to protect his eyes and some gloves." Emily said, "He has safety goggles. He's young and he's white." When asked to describe an environmental scientist, Stephen answered, "Young man...he's (pause) he has a white like doctor scientist coat on (pause). He has like a name tag...He's white." Brandi offered a different view by saying, "They could look like a regular person, like you or me...or anybody else."

Question 2: What do they (ES) do?

More than one-half of female students (55.5%, n = 5) discussed environmental scientists conducting experiments compared to 16.7% (n = 1) of male students. Only one male student mentioned experiments when talking about the work performed by environmental scientists. The following views on experiments were shared by participants:

"They experiment on plants…they do research on people."—Charity

"(They) make predictions what will happen about stuff if you take away certain things away from the environment."—Deonte

"He's making a potion to make plants stop dying."---Kayla

Emily explained her drawing (Figure 8) as follows: "He's testing a product. He's really into his work." She elaborated about all of the detail in the picture by saying it "makes his lab look active."

An equal percentage of males (n = 2) and females (n = 3, 33.3%) shared environmental scientists study and/or help animals. Stephen stated, "They see like how many animals are in the water to put if they are like extinct or not extinct like endangered. They'll keep a file about them."

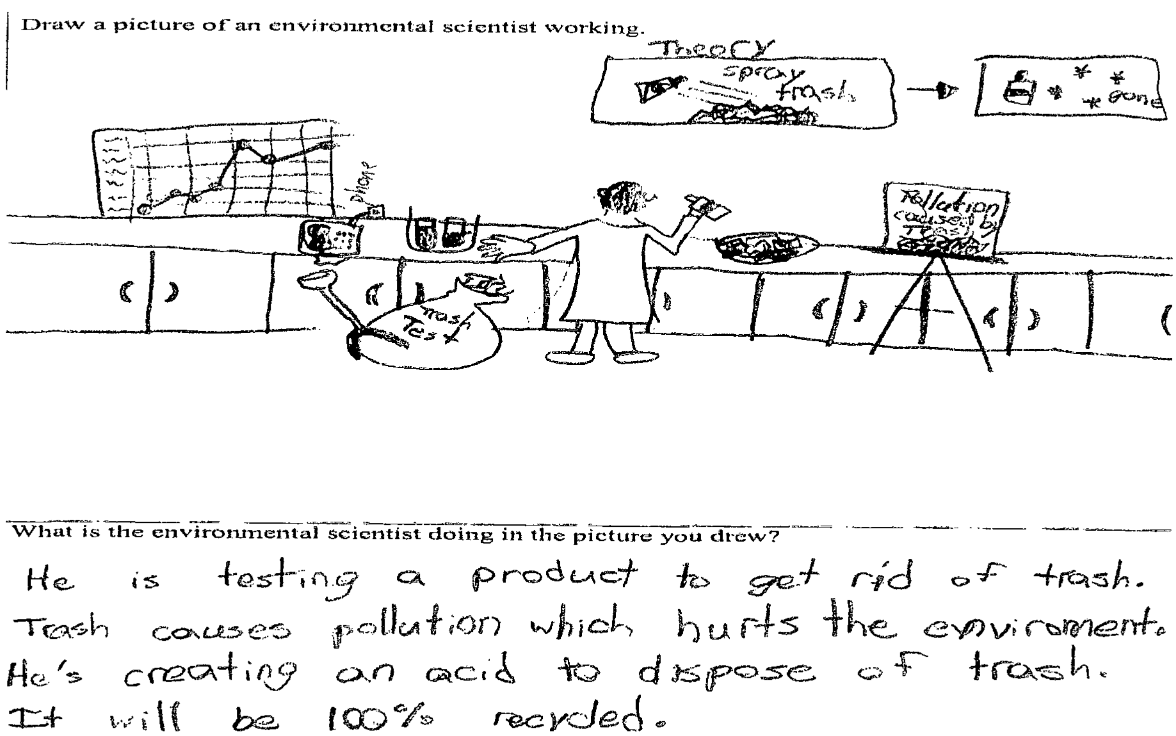


Figure 8. Environmental scientist by Emily.

About one fifth of females (22.2%, n = 2) reported environmental scientists collect samples compared to males (0%). One third of males stated environmental scientists study the weather while no female students mentioned studying weather as a function of environmental scientists. One female discussed the importance of computers in the work of environmental scientists and a male stated environmental scientists advocate for others to change their behaviors related to environmental responsibility.

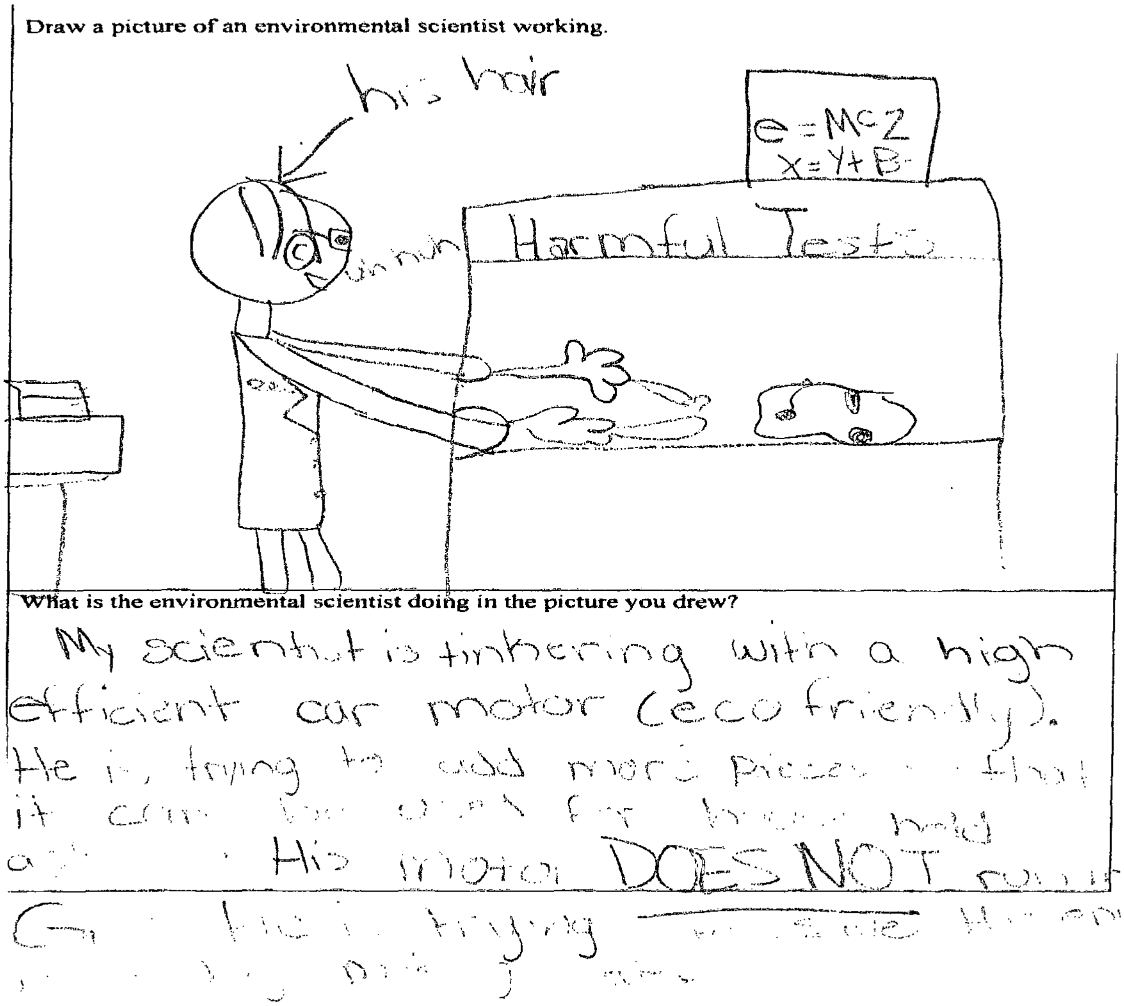


Figure 9. Environmental scientist by Maya.

Question 3: Where do they (ES) work?

Female students were more likely to report an environmental scientist worked in a laboratory (55.6%, n = 5 compared to 33.3%, n = 2 for males). A smaller percentage of each gender (16.7% for males, 11.1% of females) viewed an environmental scientist as working entirely outdoors. One-half of males and one-third of females related that the work of an environmental scientists occurred both in a lab and outdoors. Figure 9 provides an example of a female student's view of the work of an environmental scientist.

Question 4: What does someone who takes care of the environment look like?

Female students were four times more likely to mention children could be environmental caretakers while males were more likely than females (50%, n = 3 to 33.3%, n = 3) to say environmental caretakers could be any age. (Table 19 provides an overview of data from each gender). The majority of students (66.7%, n = 4 for males and 55.6%, n = 5 for females) stated an environmental caretaker could be either gender. Half of males stated environmental caretakers could be any race while an overwhelming percentage of female (88.9%, n = 8) responded similarly.

Question 5: What does someone who takes care of the environment do?

For male respondents, the two most frequently reported functions of an environmental caretaker included working with plants (50%, n = 3) and advocating (33.3%, n =3). The top two responses for females included recycling and picking up trash with 44.4% (n = 4) each. An unusual response from Merri (rich case participant) was that someone who takes care of the environment could "stop using so many harmful chemicals for their hair and stuff." She was the only female participant who spoke of reducing resource use. While more females (33.3%, n = 3) than males (16.7%, n = 1) talked about helping animals, James thought out-loud that one thing an environmental caretaker could do was "instead of maybe hunting birds you could feed birds."

Table 19

Interviewees' Views of An Environmental Caretaker

Indicator	Males	Females
Age:		
Child	1/6 (16.7%)	4/9 (44.4%)
Young/Middle Aged Adult	2/6 (33.3%)	2/9 (22.2%)
Any age	3/6 (50.0%)	3/9 (33.3%)
Gender:		
Male	2/6 (33.3%)	1/9 (11.1%)
Female		3/9 (33.3%)
Either	4/6 (66.7%)	5/9 (55.6%)
Race:		
Black	2/6 (33.3%)	
White	1/6 (16.7%)	
Mixed		1/9 (11.1)
Any	3/6 (50.0%)	8/9 (88.9%)

Samuel reported that he helps the environment by mowing the grass. This conversation revealed some misconceptions about what is helpful to the environment.

Researcher: "How does cutting the grass help the environment?"

Samuel: "Because people like they don't want their grass to get too high."

-Pause-

Samuel: "Mmmm...I forgot what I was going to say."

Researcher: "Does the lawnmower make pollution?"

Samuel: (silence)

Researcher: "Do you know what I mean by pollution? What's pollution?"

Samuel: (silence)

Researcher: "How about burning gas? Does a lawnmower do that?"

Samuel: "Yes"

Researcher: "So do you think that helps the environment?"

Samuel: "No."

This example will be discussed in the context of the research questions and other data source in Chapter V.

Question 6: Where do they (environmental caretakers) take care of the environment?

The majority of males (66.7%, n = 4) said environmental caretakers could help the environment "anywhere" compared to 44.4% 9 (n= 4) of females. When asked to explain what they meant by "anywhere" Rochelle asserted, "Wherever they see trash or a dirty place." Maya specified, "A place that's very polluted." Not only did William agree that you could help the environment anywhere, he added, "You don't have to be a scientist."

The majority of females (55.5%, n = 5) responded that a neighborhood or park was where an environmental caretaker would help the environment while males (33.3%, n = 2) named beaches and forests. James said, "pretty much mostly outside…probably the forest mostly…and near lakes and ponds…sometimes even the ocean." Only one student mentioned that someone could help the environment by choices they made indoors without further questioning from the researcher. This will be discussed further in Chapter V.

Question 7: How are you like the environmental scientist?

An interesting pattern emerged from students' responses to this question. Five of nine female students (55.6%) identified personal attributes such as being smart, curious, or a thinker. None of the male students mentioned personal attributes. Males were more likely to identify personal actions such as picking up trash, helping animals, and recycling.

> "I don't know…I do like animals."—James
>
> "If I seen a bird like that (covered in oil), I would help it."—Deonte

One interesting statement came from Andrew who said he was not like an environmental scientist. When pressed on the question, he was unable to identify a commonality between himself and an environmental scientist. Similarly, Rochelle, who could not name something she had in common with an environmental scientist said, "I'm not really good in science that well." (Rochelle).

Question 8: How are you like the person taking care of the environment?

Five out of fifteen interviewees mentioned they pick up trash. Females (26.7%, n = 4) were much more likely to talk about picking up trash than males (6.7%, n = 1). Emily, discussing water environments, made the following statement, "If you pick up trash that's on the ground it probably won't get in the water in the first place."

One third of males (n = 2) and females (n = 3) identified recycling as the job of an environmental caretaker. For females, it was the second most common response after picking up trash (Figure 10). For males, recycling and helping animals were the most common responses with 33.3% each (n = 2). Reducing resource use or reusing resources were cited less often (16.7% for males, n = 1 and 11.1% for females, n = 1). Stephen shared the following account of reducing resource use:

> I ride my bike to my friend's house and sometimes to the store…
>
> I use less water…If you want to wash your hands just quickly wash your hands like sing your Happy Birthday song then you stop when it's finished.

When asked why it was important to use less water, Stephen revealed an incomplete understanding of the issue by responding, "'Cause germs on your hands pollute the water, it could."

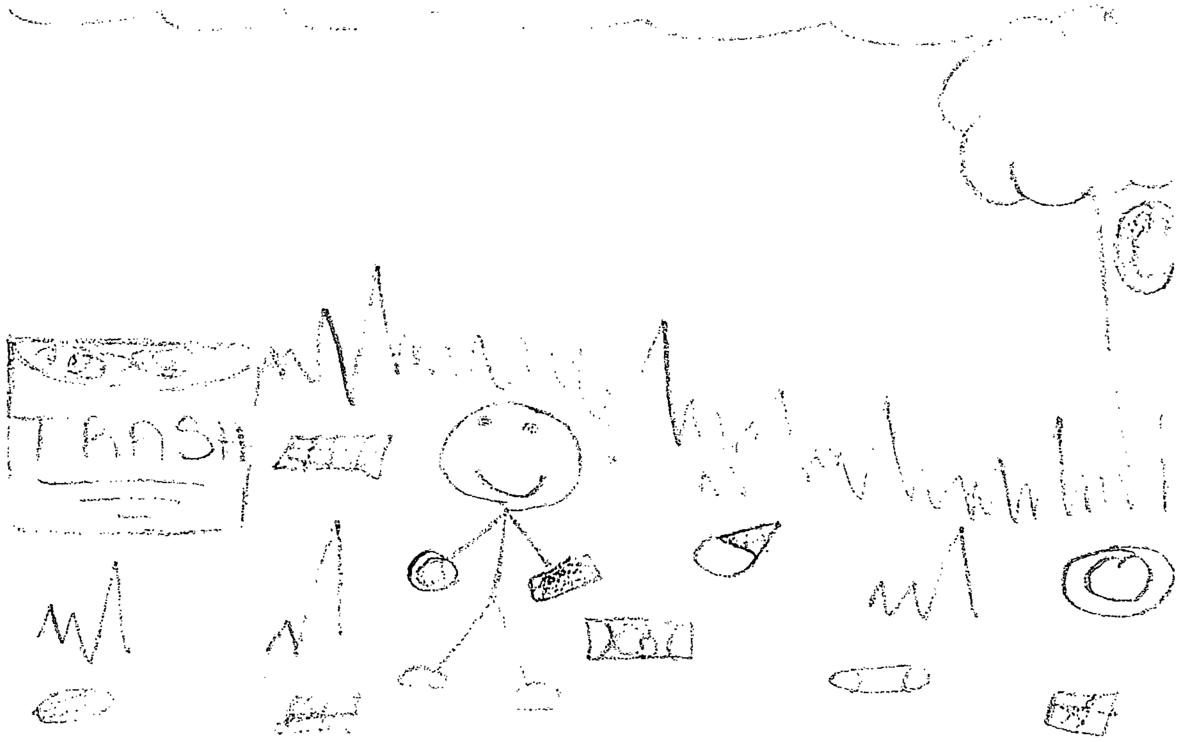
The illustration by Stephen (Figure 11) provides an example of a student's depiction of an environmental caretaker reducing resource consumption. Reducing resource use was present in only 10 out of 319 (3.1%) student illustrations of environmental caretakers. Data obtained from Stephen's interview aligned well with data presented in his environmental caretaker illustration.

Other less common environmental caretaker actions included advocating for change (16.7% for males, n = 1 and 11.1% for females, n = 1). One male (16.6%) discussed caring for plants, as did one female (11.1%). The only other response provided by interviewees included a female student's comment about trying to help the world (11.1%).

Question 9: Where do you take care of the environment?

Female students most often made connections to their homes such as when Merri said, "I recycle and use less water." She stated that she learned to conserve water by watching the Disney Channel's *Friends For Change Now*. She added, "The recycling people used to come to our street but now they don't come." Females (66.7%, n = 6) spoke of helping the environment from home twice as often as males (33.3%, n = 2).

Draw a picture of someone taking care of the environment.



What is the person doing in the picture you drew?

In my picture the person is picking up litter off the ground at a park.

Figure 10. Environmental caretaker by Brandi.

The most common response for males, and the second most common for females, was neighborhood or park. Fifty percent of males (n = 3) and one-third of females (n = 3) reported helping the environment when they were in their neighborhood or park. One-third of females (n = 3) reported helping the environment while at the beach. No responses about the beach were received from male interviewees. One-half of males (n = 3) indicated they helped the environment at school. No responses related to school were obtained from female students.

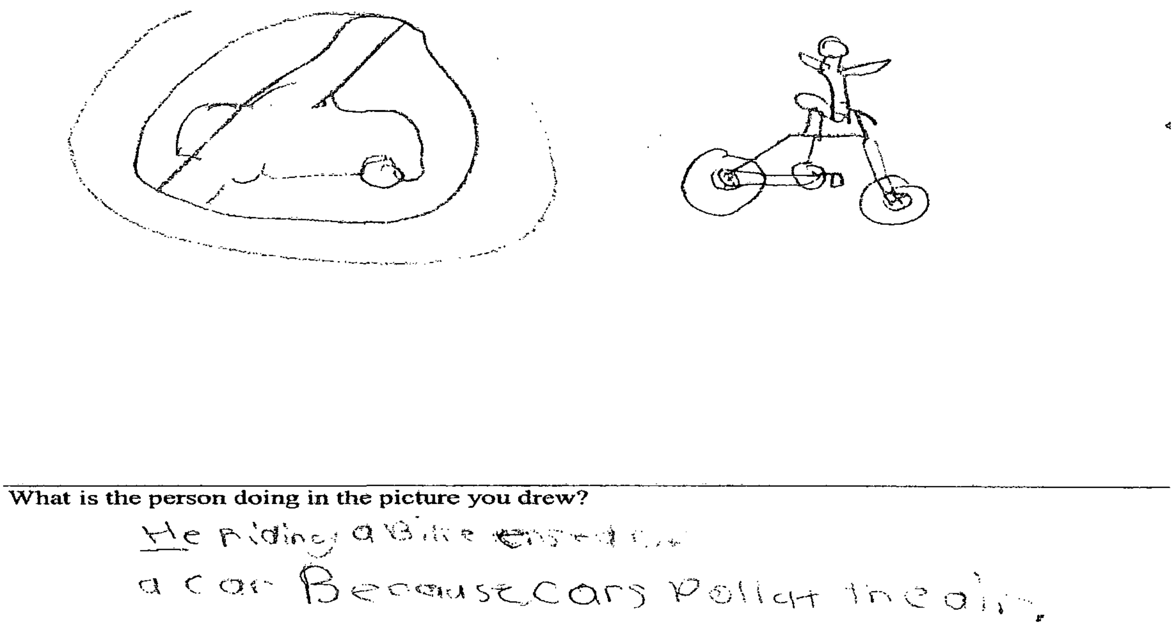


Figure 11. Environmental caretaker by Stephen.

Emergent themes

1. Students view environmental scientists and environmental caretakers as different, though they cannot explain the difference. It was noted that some students seemed to have difficulty discerning between an environmental scientist and an environmental caretaker. During follow-up probes students were asked: Are an environmental scientist and an environmental caretaker the same or are they different? Most students indicated they were different but were unable to offer further explanation. One noteworthy response came from Charity who said, "They are kind of the same because they are both helping the environment. He's research and she's hands-on. A scientist is someone who is really smart and always working." Note the gender stereotypes when Charity spoke of the two roles. The scientist was identified as male and the caretakers identified as female.

A second student, Larry, stated they were different and provided the following rationale, "A scientist studies the Earth. They have to go to college." These results will be examined in the context of the study's research questions and findings in Chapter V.

2. Environmental scientists and environmental caretakers are happy to pick up trash. Students' illustrations and interviews consistently revealed individuals smiling while picking up trash. When asked about this in interviews, students responded the people were happy because they were helping the Earth or they were making the world a better place. When asked, "Don't they ever get tired of picking up trash", students consistently said, "No, because it's good for the environment". This seems to represent an idealized and oversimplified view of the challenges and rewards of environmental action.

3. Students identify with environmental caretakers more than with environmental scientists. Students were more able to note similarities between themselves and environmental caretakers than they were with environmental scientists. Students saw taking care of the environment as something children could do and they were able to name multiple ways that they, or other children, could help the environment. Not all students were able to state something they had in common with environmental scientists (13.3%, n = 2).

4. Helping the environment occurs at a public place. Many students indicated through drawings and interviews that one needed to go to a public place such as a beach or park to help the environment. Some students were able to make connections to helping the environment from home through recycling, planting, and picking up trash. Most students interviewed were unable to provide ways to help the environment while indoors.

5. Helping the environment is primarily about recycling and restoring. Few students provided examples of reducing resource use, such as turning off lights or water. Even fewer provided examples of reusing a resource, such as refilling a water bottle. Overwhelmingly, students identified recycling and restoring an environment after it had been impacted. A very small number of students identified actions that would prevent or mitigate the impact in the first place.

6. Students' environmental pictures lack wildlife. Students who did include wildlife drew birds or fish most often. Almost none of the pictures included more than one form of wildlife. A very small number of students drew aquatic wildlife other than fish (such as oysters, starfish or crabs). Given that students in the study are from a mid-Atlantic state and live in an area where water is quite prevalent, a surprisingly small number of illustrations (11%, n = 1) depicted water environments.

7. Individuals are the only source of pollution in students' pictures. Not one student illustration showed a source of pollution other than an individual. Businesses and factories were absent. Again, given that these students live in an urban area where smokestacks are evident, it is a noteworthy omission from students' drawings.

8. Students seemed to confuse a trashcan with a recycling bin. Students sometimes used "trash can" and "recycling bin" interchangeably. For instance, their writing might have mentioned putting something in the trash while their picture showed the individual putting something in the recycling bin. This raises the question of whether or not students understand the difference between the two.

9. Difference between what people want and what is good for the environment. One student drew a picture of himself mowing the lawn to help the environment. After a discussion with the student, it became clear he had a difficult time understanding the difference between what people wanted (a freshly cut lawn) and what was good for the environment. He eventually came around to the idea that while he might have been helping his parents, he was not really helping the environment. There are definite learning opportunities for students in this area.

10. Students hold conflicting images of interactions with animals. Environmental scientists were sometimes drawn experimenting on animals while environmental caretakers were shown helping animals. The nature of human interactions with animals warrants special consideration for urban student populations. Pit bull mistreatment stories often occur in the local news. This is reflected in a student's drawing of an environmental scientist experimenting on a pit bull (Figure 12). The student indicated in his illustration that the environmental scientist was testing DNA on a dog to see how to tame the two-year old pit bull.

11. Students viewed environmental scientists and environmental caretakers as working alone. Environmental scientists were shown working with others less than 2% (n = 6) of the time. Environmental caretakers were shown with others about ten times (19.4%, n = 62) more often than environmental scientists. The nature of collaboration in environmental roles warrants further examination by EE researchers and practitioners.

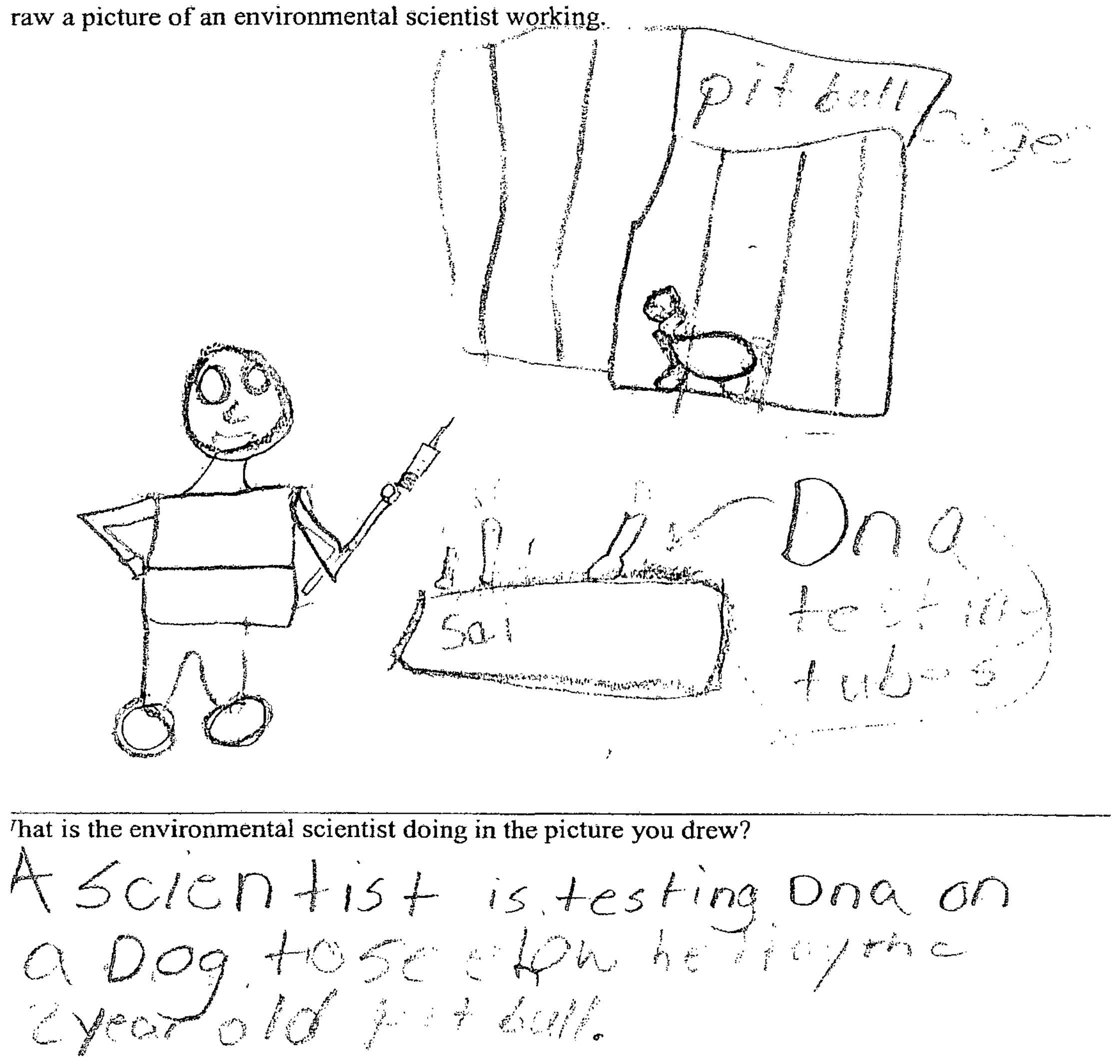


Figure 12. A male student's depiction of an environmental scientist working.

CHAPTER V

DISCUSSION

This chapter provides a summary of the study and presents findings for each of the four research questions that guided the study. Conclusions are drawn based on the results and are discussed in the context of the literature. Recommendations are provided for practitioners and researchers based on the data from this research and the literature.

Summary and Conclusions

The following conclusions were reached based on the findings of this research and the literature. The purpose of the study was to identify elementary students' views of environmental scientists, environmental caretakers, and environmentally responsible behaviors. A general conclusion from the literature, and supported by student data, is students are concerned about the current and future state of the environment (Barratt Hacking, Barratt, & Scott, 2007). Another is some of the stereotypes, particularly related to the gender of scientists, revealed in prior research (Barman, 1999; Chambers, 1983; Huber & Burton, 1995; Schibeci & Sorensen's, 1983; Sumrall, 1995) are evident among many elementary students. Students' were more likely to perceive females as environmental caretakers than environmental scientists. Conclusions for each of the four questions guiding this research are presented next.

Research Question 1: How do students view environmental scientists?

Study findings revealed stereotypical images of scientists identified in prior research (e.g., Mead & Metraux, 1957, Chambers, 1983; Schibeci & Sorensen, 1993; Sumrall, 1995, Barman, 1999, and Thomas & Hairston, 2003) were also evident in this sample of urban elementary students. The gender of the environmental scientists drawn was largely male. Students tended to draw male environmental scientists twice as often as female environmental scientists (39.1% for males versus20.3% for females. Males drew 84 male (48.6%) and 5 female environmental scientists (2.9%). Females drew 41 male (27.9%) and 60 female environmental scientists (40.8%). The percent of female environmental scientists drawn in this study exceeded those reported by Thomas and Hairston (2003). Thomas and Hairston's (2003) research with junior high and high school students showed only 11% (n = 83) of their 757 participants drew a female environmental scientist though the distribution of genders in their study was 388 females to 369 males. While participants in the current study were fifth graders, those in Thomas and Hairston's research were junior high and high school students. The grade level difference is important to note because Barman's (1999) research with over fifteen-hundred students in kindergarten through eighth grade found that as grade level increased, so did the percentage of students who drew male environmental scientists. A small positive correlation (.182), .001 level of significance, was revealed between the genders of environmental scientists and environmental caretakers. This weak relationship indicates that students may, in fact, hold different perceptions environmental scientists and caretakers.

Data from the current study further revealed students, males and females, were more likely to draw a female environmental caretaker than an environmental scientist (30.4%, n = 97 to 20.3%, n =65). This study also showed students most often included recycling (21.6%, n = 69) and restoring actions (59.2%, n =189) in their pictures. Actions depicting reducing resource use or reusing resources were not common in students' illustrations (3.1%, n = 10 and .9%, n = 3). Wildlife was lacking in students' pictures 85% of the time (n = 271).

While 40.6% of students drew environmental scientists who were gender neutral, it is noteworthy that the remainder of students drew male environmental scientists twice as often as female environmental scientists (39.1% to 20.3%). The tendency to view environmental scientists as male is consistent with findings by Thomas and Hairston (2003). In their research with junior high and high school students, only 11% of the participants drew a female environmental scientist. The percent of students to draw gender-neutral environmental scientists may reflect positive changes in cultural norms about gender roles. Still, the fact that males were drawn nearly twice as often as females is a sign that there is still work to be done.

Interview data also confirmed that students tended to view environmental scientists as males. Some findings of students' perceptions of environmental scientists are encouraging yet the percent of women to draw an environmental scientist of their own gender is exactly the percentage identified by Sumrall (1995) almost two decades ago. Sumrall suggested that self-image drawings reflect an internal locus of control. The underrepresentation of drawings of female environmental scientists may reflect a deficit in curriculum and/or educational experiences for elementary-aged females.

EE needs to do a better job of helping males and females picture women in the role of environmental scientists. This should include opportunities to interact with females in the field. While educational budget constraints may prevent face-to-face interactions, partnerships between schools and environmental scientists could provide opportunities for students to connect with such role models online. A regularly scheduled videoconference with such mentors could prove instrumental in enabling boys and girls to picture diverse individuals (gender as well as ethnicities) in the profession.

Blanchet-Cohen (2008) studied environmental involvement among 400 ten to thirteen year olds in British Columbia. She disclosed EE has the potential to foster childhood agency across six dimensions: connectedness, engaging with the environment, questioning, belief in capacity, taking a stance, and strategic action. Providing students with mentors in the field would provide students with opportunities to connect, question, and develop a belief in capacity. It would also provide students with a rich source for information on becoming an environmental scientist and the challenges and rewards of such a profession.

It is interesting that students receive quite a bit of support in athletics. Student athletes have a team, coach, trainer, recruiters for the college level, etcetera. Athletes have access to a multitude of role models as they work toward their goal of becoming a college or professional athlete. A similar such network is needed for students who choose to pursue science. The lack of mentoring and networking is a huge factor for women and was reported as a major reason why so many women left the field even after obtaining a degree in science, technology, engineering, and mathematics (STEM) (Blickenstaff, 2005).

Students' images of environmental scientists most often included symbols of research such as scientific equipment, laboratories, experiments, individuals working alone, and smiling environmental scientists. These findings highlight areas for changes in curriculum and instruction to challenge existing stereotypes and misconceptions. Students overwhelmingly drew environmental scientists (98.1%) and environmental caretakers (76.5%) working alone. Females were represented in more pictures of environmental caretakers than environmental scientists. It is possible that females better identify with the role of environmental caretaker because they see environmental caretakers' work as more collaborative than the work of environmental scientists. Research has revealed that women value social interactions on the job more than men (Weisgram & Bigler, 2006). Weisgram and Bigler's (2006) study of 617 middle school girls found that female students who heard about the altruistic value of science from female scientists, scored higher on measures of self-efficacy and utility of science than their peers. Opportunities to witness environmental scientists working with others of the same profession may be instrumental in enticing female students to the field.

Students need opportunities to observe first hand the work of environmental scientists. Students should see environmental scientists working in the field and be able to ask questions about the purpose of their work. Students have very limited views about experiments and many still hold inaccurate or incomplete perceptions about the nature of environmental scientists' work. It is unlikely that the percentage of females drawn to the field of environmental science will increase until they are provided with a curriculum and experiences that are more representative of what females value in careers.

Research Question 2: How do students view environmental caretakers?

More students drew more female environmental caretakers (30.4%) than male environmental caretakers (27.6%). Drawings depicted environmental caretakers working alone 77.1% of the time while 22.9% of environmental caretakers were depicted with at least one other person. Nineteen percent of students drew multiple individuals working together. Almost four percent of students drew multiple individuals working against each other. This finding is important because women have historically been associated with careers of service. Eccles (1987) reported females place more value on helping others in their job than males do. If students were provided with more opportunities to see environmental scientists working with others, females could be more attracted to the field.

The majority of illustrations of environmental caretakers included grass, plants, or isolated trees (55.5%). Twenty percent of illustrations were situated in urban settings such as neighborhoods or parks. Eleven percent included water habitats in their illustrations. Wildlife was noticeably absent from most drawings (85%). Where wildlife was included, it was most often birds (6.9%) and fish (3.1%). More than one species was evident in only 2.5% of the pictures.

Fifty percent of environmental caretakers were shown picking up trash from land. An additional 9.1% were depicted picking up trash from a water environment. The second most common action for environmental caretakers was recycling (13.8%). Actions such as reducing resource use occurred in only 13 out of 319 pictures (4.1%). Pictures of environmental caretakers sharing knowledge were even less common (2.5%).

Sixty-two percent of environmental caretakers were shown smiling. Students indicated in interviews that the individuals were smiling because it is good to help the Earth. Three percent of environmental caretakers were drawn frowning (twice as many as environmental scientists). Two pictures showed at least one individual smiling and one individual frowning.

Interview data revealed that students viewed children as environmental caretakers 5 out of 15 times (33.3%). A little over one-fourth of interviewees stated an environmental caretaker was male while another fourth identified them as females. Nine out of fifteen students shared environmental caretakers could be either gender.

Students are able to identify with the role of environmental caretaker. They see this role as open to individuals of both genders, and diverse ages and races. Their view of environmental caretaker actions, however, is very limited.

Research Question 3: How do students view their roles regarding environmental responsibility?

Interview data revealed 8 out of 15 (53.3%) students believed an environmental caretaker could be a child while only 3 out of 15 (20%) believed a child could be an environmental scientist. When asked what they had in common with environmental caretakers and scientists, all students were able to state how they were like environmental caretakers while some could not make a connection between environmental scientists and themselves.

Environmentally responsible behaviors in students' environmental caretaker drawings were examined and categorized by the *Four R's: Reduce, Reuse, Recycle, Restore* (Meeks et al, 2003). Actions heavily favored recycling (21.6%) and restoring (59.2%). It is interesting to note that students focused on behaviors aimed at correcting environmental harm instead of actions centered on preventing environmental harm such as reducing (3.1%) and reusing (.9%).

Research Question 4: Do male and female students have different perceptions of environmental scientists, environmental caretakers, and environmental responsibility?

Environmental Scientists

Males and females hold different views of environmental scientists. Male students drew male environmental scientists 48.6% of the time while only 2.9% of males drew female environmental scientists. Females drew environmental scientists of their own gender 40.8 % of the time and male environmental scientists 27.9% of the time. Thus, female students were almost ten times more likely than male students to draw the environmental scientist as the opposite gender.

Females used symbols of research, symbols of technology, and relevant captions more often than male students. Male students were more likely to use indications of danger and twice as likely as females to use mythic images. Females were more likely to draw their environmental scientist working in a lab. Females were also more likely to draw their environmental scientist smiling. Males were more likely than females to draw an environmental scientist without facial expression.

Environmental Caretakers

While males and females showed some differences in their views of environmental caretakers, both genders were more likely to view females as environmental caretakers than as environmental scientists. Male students drew male environmental caretakers 46% of the time while females drew female environmental caretakers 59.2% of the time. Environmental caretakers of the opposite sex were drawn 5.8% of the time by males and 6.1% of the time by females. Males were much more likely than females to draw gender-neutral environmental caretakers. Females were more than four times more likely than males to draw both genders in their environmental caretaker pictures.

Data from illustrations showed that almost half of males (84 out of 173) saw males as environmental scientists and a near equal number (79 out of 172) saw males as environmental caretakers. Females drew female environmental scientists forty percent of the time (60 out of 147) but drew female environmental caretakers much more often (87 out of 147, 59.2%). EE curriculum and instruction need to address the fact that students (males and females) are more likely to view environmental scientists as males.

Wildlife was lacking in students' pictures. Wildlife was included in 11.6% of drawings by males and 19.7% of those by females. Both genders drew birds more often than any other animal. The second most common form of wildlife drawn by both genders was fish. Females were eight times more likely to draw oysters, crabs or starfish than male students. These data reveal that students' views of environments are simplistic.

Almost 22% of females drew multiple individuals compared to 18.5% drawn by males. Females were more likely to show individuals collaborating (22.4% to 16.8%) while males were more likely to show individuals working in opposition (5.2% to 2.0%).

Environmentally Responsible Behaviors

Females drew more environmental caretakers recycling than males (15.0% to 12.7%). Girls drew more caretakers helping animals than males (4.1% to 1.7%) while more males drew caretakers sharing knowledge than females (3.5% to 1.4%). Males drew caretakers reducing or reusing resources more than twice as often as female students (5.2% to 2.0%).

Differences in the environmental caretakers use of the 4R's (Meeks et al, 2003) were noted between genders. Males showed individuals reducing resource use 5.2% of the time compared to .7% for females. Males also showed caretakers reusing resources more often than females did (1.2% to .7%). Females depicted individuals recycling more often than males (27.2% to 16.9%). Males were somewhat more likely to draw individuals restoring the environment (61% to 57.1%). EE needs to be responsive to the disparity in preventative and corrective actions practiced by students. They must be given opportunities to develop and practice a variety of action skills (Chawla & Flanders Cushing, 2007).

Females drew more pictures of multiple individuals than males (21.7% to 18.5%). Of pictures with multiple individuals, females' illustrations tended to favor cooperation (Eccles, 1987). Males showed individuals working as adversaries twice as often as females did.

Limitations

The research was descriptive and did not employ random selection of participants. Yet, because the study included approximately one-third of all fifth graders in the district, the sample was representative of the district's larger fifth grade population. This was determined by comparing demographic variables from the 5 elementary schools in the study to the 14 elementary schools in the district. This provided a reasonable degree of transferability (Patton, 2002, p. 584).

Instrumentation threats were addressed through the development of written instrument administration protocols. Teachers were also trained and observed in data collection procedures and the same teachers administered the DAEST and DAECT throughout the research to ensure uniformity in data collection.

Researher effects may have posed a threat during semi-structured interviews with students. Students were asked to speak with a researcher about environmental topics in a one-on-one setting. This may have caused anxiety for some students and may have caused some students to believe they had to provide a "right" answer. The researcher attempted to minimize any discomfort on the part of the students by talking informally with them and their teachers before the interviews. The researcher told the students there were no right or wrong answers and the researcher was just interested in what they thought about science and the environment. Additionally, the interviews were conducted at each student's home school to help students feel more comfortable throughout the interview.

The projective instruments were useful in their ability to collect data from younger participants for whom written language might have been a limitation. Semi-structured interviews allowed a deeper exploration and understanding of students' thoughts on environmental scientists, environmental caretakers, and environmentally responsible behaviors. Triangulation of data from three different sources added validity to the findings of this research.

Time and participation may have presented threats to this research. The timeline for data collection was primarily limited to four months due to district and state assessment schedules. It would have been ideal, though not feasible, to interview 10% of the participants in the study. The data collection schedule included three interviews per school for a total of 15 student interviews (roughly 5% of the participants in the study).

This number was dependent upon the willingness of parents and students to commit to the semi-structured interview process. The researcher minimized this threat by employing a liaison to keep the lines of communication open and to arrange interviews around the convenience of the schools' faculty. In addition, the researcher provided $10 gift cards to interviewees as an incentive and thank you for participation.

Implications

This study was conducted in response to a gap in the literature on students' perceptions of environmental scientists. Numerous studies have reported students' perceptions of scientists in general but such reports on elementary students' views of environmental scientists were lacking. This information may be used to inform EE curriculum and to connect new knowledge to students' prior experiences and beliefs. Findings may also be used to create curriculum that addresses students' misconceptions and stereotypes about environmental roles and behaviors.

Recommendations for Practitioners

Students' perceptions about environmental roles (scientists and caretakers) should be identified early and challenged often. It is not only important to ensure students' can see themselves in these roles, it is equally important to ensure their peers support those views as well. Data from this study indicate that boys and girls still hold gender-limiting views of who could be an environmental scientist. Huber and Burton (1995) revealed effective EE can challenge students' stereotypes and mitigate students' use of stereotypical indicators of scientists. Stereotypes held by some students can be limiting to other students in those classes. Zeldin and Pajares (2000) interviewed women who were successful in STEM fields. Their findings highlighted the impact of the views of others' on women's self-efficacy beliefs.

Students need exposure to individuals who work in these professions and whose personal attributes will further challenge students' perceptions. A connection to those in the field could help students develop a sense of agency and a belief in their capacity to make a difference (Blanchet-Cohen, 2008).

Students' views of environmental careers need to be broadened. Several students indicated they were not likely to be in environmental careers because they were interested in fields such as law or animal care. Students need help making connections between fields that interest them and environmental protection careers. This could be accomplished through a curriculum that is owned by the student (Hungerford et al, 2000), a lived curriculum (Roth & Lee, 2002).

Students clearly demonstrated an understanding of the importance of recycling and responding to or restoring damaged environments. The relative lack of demonstrated awareness of reducing resource use or reusing resources is very important for practitioners especially since students cover the importance of protecting resources in Virginia Standards of Learning for both science and health (www. doe.virginia.gov). The standards emphasize the need to understand the value of resources but do not specify environmentally responsible behaviors such as reducing, reusing, restoring, and recycling. If students are focusing on correcting environmental harm but not learning and implementing practices to prevent environmental harm in the first place, this huge disconnect must be addressed. Teachers should begin reinforcing preventative measures over corrective measures. Teachers should model environmentally responsible behaviors regularly. Students should have opportunities to identify and implement ways to use fewer resources throughout their day. They should also be challenged to identify and incorporate ways to reuse resources more often. Students need lessons in the value of prevention as opposed to the ways to correct damages that could have been avoided. Science education should aim to equip students with the skills needed to act responsibly toward the environment (Colucci-Gray et al, 2006).

The importance of collaboration in environmental careers is something students are not identifying. Too often students see snapshots of environmental scientists working in isolation. They must have opportunities to view environmental scientists working in conjunction with others to advance their work. While more students highlighted collaboration among environmental caretakers, almost three-fourths of the students did not. Students need opportunities to work with others on behalf of the environment. This is something that I have personally tried to change about some school science fairs. Students are often required to work individually, further reinforcing the stereotype of the isolated and independent scientist.

Students need to hear first hand from individuals in the field about the challenges and rewards of environmental work. The fact that students tended to draw scientists and caretakers smiling could be an indication of students' oversimplification of the challenges and nature of the work.

Students need explicit instruction and practice in how to help the environment from their own homes, indoors as well as outdoors. Students often indicated individuals needed to go to a public place (park or beach) to help the environment. The EPA emphasized it is the millions of little choices made by individuals and companies each day that can collectively have a significant impact on the overall health of the environment (EPA, 2006). Students indicated that "other individuals" were the causes of pollution. It is important that EE help students understand we all impact the Earth in some way. This would help students become more aware of their impact and take ownership for ways they could personally make a difference through their individual choices.

There is clearly a place for Humane Education in EE. Students who do not value living things are not likely to value and care for the inanimate objects in their environment either. Humane Education is particularly needed for urban students who may lack meaningful interactions with animals (domesticated or wild). Children deserve an education that is relevant to their lives. EE should empower students to respect all forms of life. As Margaret Mead asserted, "To teach a child not to step on a caterpillar is as important to the child as it is to the caterpillar."

Recommendations for Researchers

A study of current EE programs that have shown promise in promoting positive student perceptions about environmental work would be helpful in guiding the work of other educators. More research on the use of varied science pedagogies with male and female students would be beneficial to the conversation. It is important that the content and methods of environmental instruction are designed to maximize the potential of each student. As Blickenstaff (2005) reported, components of course design, such as scope and depth, affect males and females differently.

While great strides have been made in addressing gender inequities in textbooks, research on the images of environmental scientists, and scientists in general, displayed in the media need to be examined further. The gender of the scientists depicted is important but so is the context. It is important to know how often students encounter images of scientists working with others and scientists working outside of a lab. Students are part of the media generation and, as was demonstrated in this research, may develop perceptions and misconceptions before entering an EE class. What those informal education images look like is worth further examination.

Research on interventions that could be implemented by teachers and parents to counter gender stereotypes held by students is needed. Studies on exemplary programs that partner female students with older female science students and those in the profession could shed light on the importance of such partnerships and lead to further support programs being put into place.

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APPENDICES

APPENDIX A

IRB approval

From: Maihafer, George C.
Sent: Saturday, June 20, 2009 1:31 PM
To: Dickerson, Daniel L.
Subject: June IRB meeting minutes

Dear Dan-

Below are the minutes from the recent IRB meeting as they pertain to your study.

Please make the corrections listed below and send me 1 printed copy of the application and 2 printed copies of all of the informed consent documents. I in turn will review them, stamp the informed consent documents and send you one of the copies. The rest of the material will be sent to the Office of Research.

Review of Daniel Dickerson's Proposal, "STEM Education and Professional Studies," (COD NAME: SEARCH – NOAA) (ODU IB # 09-069), STEM education and Professional Studies, Darden College of Education, is approved

APPENDIX B

IRB Identifier:__________
(To Be Assigned by the IRB)

INFORMED ASSENT/CONSENT DOCUMENT – Students/Parents
OLD DOMINION UNIVERSITY

PROJECT TITLE: Science Education Advancing Research of the Chesapeake Bay and its Habitats (**SEARCH**)

INTRODUCTION

The purposes of this form is to give you/your child information that may affect your/your child's decision whether to say YES or NO to participation in this research study at your/your child's school entitled, **Science Education Advancing Research of the Chesapeake Bay and its Habitats (SEARCH)**, and to record the consent of those who say YES.

RESEARCHERS

Daniel Dickerson, PhD Responsible Project Investigator Associate Professor Darden College of Education Department of STEM Education and Professional Studies Old Dominion University Sueanne McKinney, PhD Assistant Professor Darden College of Education Department of STEM Education and Professional Studies Old Dominion University	Eileen Hofmann, PhD Professor Center for Coastal Physical Oceanography Old Dominion University

DESCRIPTION OF RESEARCH STUDY

The purpose of the study is to learn how professional development activities help enhance teacher attitudes, awareness, and content knowledge regarding science, math, and engineering. Additionally, we will be examining the efficacy of the program (e.g. how teacher training impacts student learning).

If you and your child decide to participate, then your child will join a study involving research about professional development. Some teachers in the study will be participating in the professional development activities and some will not. Consequently our child may or may not be in a class where the teacher is participating in Project SEARCH's professional development program. Either way, as part of the study your child will be asked to complete short questionnaires and concepts maps and participate in videotaped interviews. All videotaped data from interviews will be transcribed and the transcriptions will be analyzed. After the data have been analyzed, the tapes will be destroyed. We will not disseminate any information, oral or written, that identifies your child or your child's participation with this study. The only exception will be if you and your child allow us to use your child's image in publications (e.g. NSTA's *Science Teacher*) or professional presentations. Even then we will not use your child's name or any other identifying information about your child. Permission to use your child's image will be secured through a separate photo release form. Your child's participation in this study is in NO way linked to his or her grade. If you and your child say YES, then your child's participation will last for approximately three hours over the course of one year and will be part of your child's normal classroom instruction. We are simply trying to find out how professional development activities change teacher attitudes, awareness, and content knowledge regarding science, math, and engineering, how those changes impact student learning, and whether or not what we are doing is effective. Approximately 1800 students will be participating in this study. There will be approximately three data collection sessions over the course of one year. Each session will last approximately one hour for a total of three hours over the course of the students' school year.

RISKS AND BENEFITS

There are no risks associated with this study beyond what are normally experienced in typical classroom settings. No information that identifies your child or your child's participation with this study will be used without you and your child's permission. Your child's participation in this study is in NO way linked to his or her grade.

BENEFITS: There are no direct benefits for participation. Indirect benefits include being exposed to in-depth study of science in innovative, real-world settings based on content that may directly positively impact career pathways

If the researchers find new information during this study that would reasonably change your or your child's decision about participating, then they will give it to you and your child.

CONFIDENTIALITY
The researchers will take reasonable steps to keep all information confidential. Only the researchers will see the data and will keep all data in a locked filing cabinet prior to its processing. The results of this study may be used in reports, presentations, and publications; but the researcher will not identify your child. Of course, your child's records may be subpoenaed by court order or inspected by government bodies with oversight authority.

WITHDRAWAL PRIVILEGE
It is OK for you and your child to say NO. Even if you and your child say YES now, you and your child are free to say NO later, and walk away or withdraw from the study -- at any time. You and your child's decisions will not affect your child's relationship with Old Dominion University, or otherwise cause a loss of benefits to which your child might otherwise be entitled.

COMPENSATION FOR ILLNESS AND INJURY.
If you and your child say YES, then your child's consent in this document does not waive any of your child's legal rights. However, in the event of injury arising from this study, neither Old Dominion University nor the researchers are able to give you or your child any money, insurance coverage, free medical care, or any other compensation for such injury. In the event that your child suffer injury as a result of participation in any research project, you may contact Daniel Dickerson, Responsible Project Investigator, at 757-683-4676 or Dr. George Maihafer, the current IRB chair, at 757-683-4520 at Old Dominion University, who will be glad to review the matter with you.

VOLUNTARY CONSENT
By signing this form, you and your child are saying several things. You and your child are saying that you and your child have read this form or have had it read to you and your child, that you and your child are satisfied that you and your child understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you and your child may have had about the research. If you or your child have any questions later on, then the researchers should be able to answer them: Daniel Dickerson, Responsible Project Investigator, at 757-683-4676

If at any time your child feels pressured to participate, or if you and your child have any questions about your child's rights or this form, then you should call Dr. George Maihafer, the current IRB chair, at 757-683-4520, or the Old Dominion University Office of Research, at 757-683-3460.

And importantly, by signing below, you and your child are telling the researcher YES, that your child agrees to participate in this study. The researcher should give you a copy of this form for your records.

Subject's Printed Name & Signature	Date
Parent / Legally Authorized Representative's Printed Name & Signature	Date

INVESTIGATOR'S STATEMENT
I certify that I have explained to this subject the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the subject's questions and have encouraged him/her to ask additional questions at any time during the course of this study. I have witnessed the above signature(s) on this consent form.

Investigator's Printed Name & Signature	Date

Approved Institutional Review Board - ODU

JUN 18 2009

INFORMED ASSENT/CONSENT DOCUMENT
FOR USE OF PHOTO/VIDEO MATERIALS - Students/Parents

STUDY TITLE: Science Education Advancing Research of the Chesapeake Bay and its Habitats (SEARCH)

DESCRIPTION:

The researchers would also like to take photographs or videotapes of you/your child engaged in the professional development program in order to illustrate the research in teaching, presentations, and/or or publications.

CONFIDENTIALITY:

All videotaped data from interviews will be transcribed and the transcriptions will be analyzed. After the data have been analyzed, the tapes will be destroyed. We will not disseminate any information, oral or written, that identifies your participation with this study. The only exception will be if you allow us to use your image in publications (e.g. NSTA's *Science Teacher*) or professional presentations. Even then we will not use your name or any other identifying information about you. You will not be identified by name in any use of the photographs or videotapes. Even if you agree to be in the study, no photographs or videotapes of you will be used in publications or presentations unless you specifically agree to this.

VOLUNTARY CONSENT

By signing below, you are granting to the researchers the right to use your likeness, image, appearance and performance - whether recorded on or transferred to videotape, film, slides, photographs - for presenting or publishing this research. No use of photos or video images will be made other than for professional presentations or publications. The researchers are unable to provide any monetary compensation for use of these materials. You can withdraw your voluntary consent at any time.

If you have any questions later on, then the researchers should be able to answer them: Daniel Dickerson, Responsible Project Investigator, at 757-683-4676. If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should call Dr. George Maihafer, the current IRB chair, at 757-683-4520, or the Old Dominion University Office of Research, at 757-683-3460.

Subject's Printed Name & Signature	Date
Parent / Legally Authorized Representative's Printed Name & Signature	Date
Investigator's Printed Name & Signature	Date

Approved Institutional
Review Board - ODU

JUN 18 2009

Expires 1 year from date
Questions: 757-683-3460

Revised 3/05

APPENDIX C

DAEST and DAECT administration protocol

The teacher reads the following to students:

"Researchers at ODU want to know what fifth graders think about the environment. They would like you to complete two drawings this morning. If you don't think you can draw, that is okay. You can use stick figures if you need to."

The teacher says:

"You will have ten minutes to work on your picture after I read the directions to you. I will not be able to answer any questions during that time. Just remember, there are no right or wrong answers. Also, because researchers want to know what you think, please do not talk to your neighbors or look at their papers."

Teacher passes out papers.

The teacher says:

"Do not put your real name on this paper. Instead, use your call name and class name."

Once students are ready, the teacher reads the directions aloud (from the paper handed out to students).

Start time.
It is okay to let students know when they have a couple of minutes left.
Stop at end of ten minutes. Collect papers.
Repeat above steps with the other drawing instrument.

APPENDIX D

Draw-An-Environmental-Scientist Test (DAEST)

Call Name: ______________________________ Class: __________________________

Draw a picture of an environmental scientist working
What is the environmental scientist doing in the picture you drew?

APPENDIX E

Draw-An-Environmental-Caretaker Test (DAECT)

Call Name: ______________________________ Class: _______________________

Draw a picture of someone taking care of the environment
What is the person doing in the picture you drew?

APPENDIX F

Semi-structured Interview Questions Development Blueprint

	Identity	Role	Location
Environmental Scientist	#1	#2	#3
Environmental Caretaker	#4	#5	#6
You (Student)	#7	#8	#9

The final SSI protocol contains 9 questions (Appendix G). The question numbers inside the table correspond to the title of individual (scientist, caretaker, or student) and construct (identity, role, or location) examined in the interview process. In addition to the pre-established questions, probes were utilized that were responsive to the evolution of the interview and data collection process.

APPENDIX G

Semi-structured Interview Protocol

1. What does an environmental scientist look like?
2. What do they do?
3. Where do they work?
4. What does someone who takes care of the environment look like?
5. What do they do?
6. Where do they take care of the environment?
7. How are you like the environmental scientist?
8. How are you like the person taking care of the environment?
9. Where do you take care of the environment?

APPENDIX H

Data Collection Schedule For DAEST and DAECT

Month	Number of Schools	Number of Classes	Number of Students
December 2009	1	4	85
January 2010	2	6	116
February 2010	2	5	119
Totals	5	15	320

Data Collection Schedule for Semi-Structured Interviews

Semi-structured interviews were arranged to occur within three weeks of students' DAEST and DAECT drawings. Interviews occurred at students' home schools. The researcher interviewed 3 students per school for a total of 15 student interviews. All interviews were completed by the 10th of March 2010.

APPENDIX I

Student Gender Distribution for Groups 1 and 2

Demographics	Group 1 DAEST First	Group 2 DAEST Second
Male Students	53.5%	54.7%
Female Students	46.5%	45.6%

(Group 1: N = 172; Group 2: N = 148)

DAEST Frequencies of Indicator Use by Group

Indicator	Group 1 DAEST First	Group 2 DAEST Second
Lab coat	9.9%	10.8%
Glasses/goggles	17.4%	9.5%
Facial hair	.6%	3.4%
Symbols of research	46.5%	45.3%
Symbols of knowledge	15.7%	9.5%
Symbols of technology	15.7%	16.2%
Relevant captions	8.1%	15.5%
Gender of scientist:		
Male	37.8%	41.2%
Female	18.0%	22.3%
Not evident	43.0%	36.5%
Danger	9.3%	8.8%
Mythic images	1.2%	3.4%
Secrecy	0%	.7%
Savior reference	1.7%	4.1%
Setting:		
Laboratory	44.8%	43.2%
Outdoors	35.5%	33.8%
Laboratory and outdoors	.6%	1.4%
Not evident	19.2%	21.6%
Nature of work:		
Observing	22.1%	18.2%
Measuring	.6%	.7%
Collecting	12.2%	8.8%
Experimenting	39.5%	35.8%

Reporting	1.7%	4.7%
Collaborating	.6%	2.7%
Picking up trash/recycling	6.4%	17.6%
Caring for plants	7.0%	.7%
Caring for animals	1.7%	2.0%
Other	1.2%	1.4%
Not evident	7.0%	7.4%
Emotions of scientist:		
Joy	68.6%	60.8%
Sadness	.6%	1.4%
Not evident	30.8%	37.8%

(N = 320)

Mann-Whitney Tests for Significance of DAEST Indicator Usage by Group

Indicator	Sig.
Lab coat	.676
Glasses/goggles	.056
Facial hair	.066
Symbols of research	.824
Symbols of knowledge	.096
Symbols of technology	.900
Relevant captions	.029
Gender of scientist	.238
Age of scientist	.067
Indications of danger	.872
Lightbulbs	1.000
Mythic images	.177
Secrecy	.281
Savior reference	.213
Setting of work	.604
Nature of work	.095
Emotions	.157

APPENDIX J

Student Gender Distribution for Groups 1 and 2

Demographics	Group 1 DAECT Second	Group 2 DAECT First
Male Students	53.5%	54.7%
Female Students	46.5%	45.6%

(Group 1: N = 172; Group 2: N = 148)

DAECT Frequencies of Indicator Use by Group

Indicator	Group 1 DAECT Second	Group 2 DAECT First
Gender of caretaker:		
Male	30.2%	24.5%
Female	28.5%	32.7%
Not evident	39.0%	38.8%
Number of individuals:		
None	0%	.7%
One	78.5%	76.2%
Two	16.3%	16.3%
Three	2.3%	1.4%
Four or more	2.9%	4.8%
Reference to self	5.8%	2.7%
Age of caretaker:		
Adult	11.0%	9.5%
Child	15.1%	17.7%
Not evident	73.3%	72.8%
Savior reference	2.3%	3.4%
Setting of work:		
Water environment	10.5%	12.2%
Mountains	.6%	0%
Forest	1.2%	2.7%
Soil/grass/isolated trees	55.2%	55.8%
Urban/houses, park	23.8%	16.3%
Indoors	1.7%	2.0%
Not evident	7.0%	10.9%

Wildlife:		
Birds	6.4%	7.5%
Fish	2.9%	3.4%
Oysters/crabs/starfish	.6%	4.8%
More than one species	3.5%	1.4%
None	86.6%	83.0%
Nature of work:		
Picking up trash from land	58.7%	40.8%
Picking up trash from water	8.7%	9.5%
Planting/caring for plants	10.5%	17.0%
Recycling	12.8%	15.0%
Caring for animals	1.2%	4.8%
Sharing knowledge	1.7%	3.4%
Reducing/reusing resources	4.7%	2.7%
Not related to topic	.6%	.7%
Not evident	.6%	5.4%
Emotions of caretaker:		
Joy	65.7%	58.5%
Sadness	2.9%	3.4%
Not evident	30.8%	37.4%
More than one emotion	.6%	.6%
Four R actions:		
Reduce	2.3%	4.1%
Reuse	1.7%	0%
Recycle	22.7%	20.5%
Restore	61.6%	56.8%
Nature of group interactions:		
None	77.9%	74.3%
Working together	19.2%	19.6%
Working in opposition	2.3%	5.4%

(N = 319)

Mann-Whitney Tests for Significance of DAECT Indicator Usage by Group

Indicator	Sig.
Caretaker gender	.400
Number of individuals	.760
References to self	.075
Age of caretaker	.850
Savior reference	.564
Setting of work	.613
Wildlife	.079
Caretaker actions	.235
Emotions of caretaker	.189
Four R actions	.242
Nature of group interactions	.386

CURRICULUM VITAE

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Education:

Bachelor's Degree:

Name of Degree: BS, 1982
Degree-granting Institute: College of William and Mary
Major Field of Study: Biology

Master's Degree:

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Degree-granting Institute: Old Dominion University
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Virginia Postgraduate Teaching Licensure:

Licensure renewed through July 2014 for preK-6

Doctoral Degree:

Name of Degree: Ph.D., 2010
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Major Field of Study: Curriculum and Instruction/Science Education

Dissertation: Urban Elementary Students Views of Environmental Scientists, Environmental Caretakers, and Environmentally Responsible Behaviors

Research Papers Presented at Professional Meetings:

Dickerson, D.L., Horne, P., Hotchkiss, R., McKinney, S., & Verma, A. (2009, November). MarineTech - Density, buoyancy, and boats. To be presented at the annual meeting of the Virginia Association of Science Teachers (VAST), Washington, DC.

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