Spring 5-1-2013

The Role of Service-Learning on College Students' Environmental Literacy: Content Knowledge, Attitudes, and Behaviors

Joanna Lynn Bush Singletary
University of Southern Mississippi

The University of Southern Mississippi

THE ROLE OF SERVICE-LEARNING IN COLLEGE STUDENTS'

ENVIRONMENTAL LITERACY: CONTENT KNOWLEDGE,

ATTITUDES, AND BEHAVIORS

by

Joanna Lynn Bush Singletary

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

May 2013

ABSTRACT

THE ROLE OF SERVICE-LEARNING IN COLLEGE STUDENTS'

ENVIRONMENTAL LITERACY: CONTENT KNOWLEDGE,

ATTITUDES, AND BEHAVIORS

by Joanna Lynn Bush Singletary

May 2013

This study evaluated the relationship of environmental service-learning on
environmental literacy in undergraduates. The subjects were 36 undergraduates at a small
liberal arts university enrolled in an environmental biology course.To determine the role
of environmental service-learning on college students' environmental knowledge,
attitudes, behaviors, and environmental literacy, this study utilized concurrent mixed
methods approach for qualitative and quantitative analysis. A quasi-experimental
repeated measures approachwas the design of the quantitative component of the
study.Data were collected on attitude, behavior, and content knowledge aspects of
environmental literacy as measured by the Environmental Literacy Survey (Kibert, 2000).
Hypotheses were tested by independent samples $t$tests and repeated measures
ANOVA.Repeated measures ANOVA conducted on participants' three subscales scores
for the Environmental Literacy Survey (attitude, behavior, and knowledge) indicated that
students who participated in environmental service-learning scored statistically
significantly higher than those that did not initially participate in service-learning.
Qualitative data collected in the form of journal reflections and portfolios were evaluated
for themes of environmental attitudes or affective statements, environmentally positive
behaviors and skills, and ecological content. Quantitative and qualitative data support the

ii

positive role of environmental service-learning in the development of environmental

literacy in undergraduate students.

The University of Southern Mississippi

THE ROLE OF SERVICE-LEARNING IN COLLEGE STUDENTS'

ENVIRONMENTAL LITERACY: CONTENT KNOWLEDGE,

ATTITUDES, AND BEHAVIORS

by

Joanna Lynn Bush Singletary

A Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

Approved:

_Sherry Herron_____ ____
Director

_Mac Alford _____

_Kyna Shelley_____ _____

_Kristy Halverson_____

_Susan A. Siltanen_____
Dean of the Graduate School

May 2013

ACKNOWLEDGMENTS

TABLE OF CONTENTS

           Statement of the Problem
           Delimitations
           Assumptions
           Definition of Terms
           Justification

           Service-Learning
           Theoretical Foundation
           Environmental Education and Environmental Literacy
Environmental Service-Learning
           Justification for Campus-Based Environmental
                Service-Learning

           Research Design
           Participants
           Instrumentation
           Procedure
           Instructional Treatment
           Data Analysis

           Findings
           Research Questions
           Summary

LIST OF TABLES

Table

LIST OF ILLUSTRATIONS

Figure

CHAPTER I

INTRODUCTION

The current emphasis on environmental education is a resurgent trend in science education. A nexus occurred in the 1960s whereby environmental issues, scientific studies of ecology, and a liberal political element of society merged which resulted in an increased awareness of the need for environmental education. During this time period, the emerging scientific study of ecology provided evidence for the interconnectedness among humans, other living organisms, and the physical world. In 1962, Rachel Carson's book, *Silent Spring*, unleashed a fear of chemical pollution and awareness that environmental degradation could have long-term, devastating consequences. This landmark book by Carson raised the world's consciousness of environmental pollution and degradation due to the actions of humans. Carson carefully researched chemical pollution and its effects on the environment and human health. Her attention to scientific data developed a compelling case for the effects of dichlorodiphenyltrichloroethane (DDT). Carson's book helped kindle environmental activism and provided public support for the government to install new regulations and policy to protect the environment.

In addition to awareness of environmental issues, a new theme of science-technology-society (STS) in education was emerging in the latter parts of the 1960s and early 1970s(DeBoer, 1991). STS's goals were to incorporate personal, societal, and environmental concerns into science education. Social issues and values became a focus for science education. Bybee (1979) advocated that environmental and ecological themes should be the showcase for the STS curriculum. The study of ecology was providing evidence for the interconnectedness of the physical world, living organisms, and humans.

Introspection and the impact of human actions enhanced the perspective on environmental ethics. On April 22, 1970, the nation held its first Earth Day—the same year the National Environmental Education Act was passed. A new view of human's place in the world, the social issues of pollution, and STS educational emphasis provided the impetus for environmental education curriculum in K-12 grades. Internationally, a number of conferences and workshops in the 1970s, such as the UN Conference on the Human Environment, strengthened the goals and objectives for environmental awareness and education.

Three decades later Bybee (2010) continues to press for science education that can prepare students for the 21[st]century workforce. Bybee further calls for citizens who are scientifically literate and prepared to contribute in addressing society's complex issues. Many of the greatest challenges that society currently faces are connected to environmental issues, such as habitat loss, climate change, environmental degradation, human health, and species extinctions. Citizens with knowledge and skills related to environmental science may be better prepared and more committed to looking for solutions to these complex issues.

Environmental literacy is an interface between science knowledge and social science whereby learners understand how natural systems function and then can use that knowledge in making decisions and choices. *Environmental literacy,* as defined by Roth (1992),is "the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems" (p. 10). Roth maintains that environmental literacy should be the primary goal of environmental education with schools playing a major role toward that objective.

In the pursuit of strategies in science education, service-learning is an advocated form of experiential or active learning. Service-learning is an educational method or pedagogy that connects academic content with community service. Research on service-learning has shown its effectiveness inK-12 and higher education (Boyle-Baise et al., 2006; Haines, 2010; Handa et al., 2008). Service-learning experiences in higher education can provide a range of interdisciplinary learning opportunities which can influence group process skills, career opportunities, character development, and a sense of social and civic responsibility (Conville & Weintraub, 2001).Brown, Collins, and Duguid (1989) stressed the importance of the social nature of learning in authentic settings. Brown et al. described learners as novices or apprentices initially, then advancing in learning through practicing authentic skills and social collaborative experiences.

Service-learning can provide active learning outside the classroom through hands-on tasks that link environmental biology content to real-world environmental issues. Environmental service-learning can specifically illustrate biological concepts, such as biodiversity, species extinction, evolution, habitat loss, climate change,impact of pollution, sustainability, environmental protection, and conservation. Citizens who are more environmentally literate understand the biological and scientific concepts of these environmental problems and may be better prepared for meaningful contributions to solutions. Environmental service-learning may encourage and develop citizens who are more engaged in democratic decision-making and environmental stewardship.

Statement of the Problem

Research Question

Does participation in an environmental service-learning project have an impact on environmental literacy in undergraduate students enrolled in biology courses?

*Specific research question*s.

1. What is the relationship of environmental service-learning on *attitudes* regarding environmental issues in undergraduate students enrolled in a biology course?

2. What is the relationship of environmental service-learning on students' *environmentally positive behaviors*?

3. What is the relationship of service-learning on *conceptual learning* and *knowledge of scientific conten*t relative to ecological and environmental education in students enrolled in undergraduate biology courses?

Research sub-problem. Were there significant differences in student subpopulation (e.g., male or female, age,and major) scores in the three sections (attitude, behavior, and knowledge) and the total environmental literacy score as measured by the Environmental Literacy Survey?

Hypotheses

Students who participated and completed an environmental service-learning project performed significantly higher on an instrument designed to measure environmental literacy (i.e., affective, behavior, and cognitive subscales) than students who did not participate in an environmental service-learning project.

1. Students' *attitude* or affective scores will be statistically higher after environmental service-learning.

2. Students' *behavior* scores will be statistically higher after environmental service-learning.

3. Students' *knowledge* scores for environmental and ecological content will be statistically higher after environmental service-learning.

4. Students' *environmental literacy* scores will be statistically higher after service-learning.

Delimitations

The study has the delimitation that the generalizability of any result is limited to the population under discussion.

Assumptions

This study attempted to determine the role of environmental service-learning on college students' environmental knowledge, attitudes, behaviors, and environmental literacy. It will be assumed that the participants in this study will provide accurate and honest information concerning their environmental knowledge, attitudes, and behaviors.

Definition of Terms

The following is a list of terms and their meanings with reference to this study:

Environmental literacy. "The capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems" (Roth, 1992, p. 10).

Service-learning. Service-learning is a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the

learning experience, teach civic responsibility, and strengthen communities (National Service-Learning Clearinghouse, 2012).

Justification

Workers in the 21st century will need more than ever critical thinking, problem-solving, and communication skills (Bybee, 2010). Technology and work environments are likely to change at an ever-increasing pace. Service-learning involves active learning in hands-on tasks that link environmental biological principles to real-world problems. These experiences can expose students to environmental science concepts, career possibilities, and group process skills. Additionally, service-learning experiences may help develop character and promote civic responsibility (Giles & Eyler, 1994a; Hamilton & Zeldin, 1987). The abilities of problem-solving and group process skills could prepare students for challenging careers and the demands of future employers. Furco and Root (2010) stated that more evidence-based research focusing on the benefits of service-learning in K-12 and higher education is needed. Undeniably, there is a need for any form of research on service-learning.

This study will add to the existing knowledge of environmental service-learning, and by its design could avoid some threats to validity, such asself-selection, resentful demoralization, quality of environmental service-learning, limitation to diffusion of treatment, and different instruction. This quantitative and qualitative study has the benefit of environmental service-learning that is more uniform in design and incorporates quality standard service-learning practices.

Complex environmental problems of the 21st century will require informed citizens with capabilities of problem-solving and a strong sense of environmental stewardship (Bybee, 2010). Attitudes and behaviors that are more environmentally

friendly may translate to more active participation in environmental issues. Experiences in environmental service-learning in higher education may foster environmental literacy and environmental stewardship. Environmental literacy may serve as the foundation and provide skills to address the complex environmental problems of sustainability, habitat loss, species extinction, pollution, and population growth.Our society's decisions and collective choices will affect the biosphere and ourselves as we are an essential component of these ecosystems.

Many of the topics and issues related to environmental science are filled with negative effects of environmental degradation. Students of environmental science may feel demoralized and develop a sense that there is little that can be done to counteract the myriad environmental problems. Student engagement in service-learning projects may give hope and empower students to experience more positivitytoward a more sustainable world.

CHAPTER II

REVIEW OF RELATED LITERATURE

Service-Learning

Service-learning is described as a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities (National Service-Learning Clearinghouse, 2012). Service-learning research suggests that service-learning increases students' critical thinking skills and students' ability to understand and apply more complex academic material (Billig, 2000; Eyler & Giles, 1999; Eyler, Root, & Giles, 1998). The National and Community Service Act of 1990 defines and describes the term *service-learning* as a method:

(A) under which students or participants learn and develop through active participation in thoughtfully organized service that (i) is conducted in and meets the needs of a community;(ii) is conducted with an elementary school, secondary school, institution of higher learning, or community service program, and with the community; and(iii) helps foster civic responsibility; and

(B) that (i) is integrated into and enhances the academic curriculum of the students, or the educational components of the community service program in which the participants are enrolled; and(ii) provides structured time for the students or participants to reflect on the service experience. (p. 5)

Service-Learning Theoretical Framework and Models

The learning theories of Dewey, Vygotsky, Kolb, and others provided the theoretical foundation for service-learning (Dewey, 1938; Kolb, 1984; Vygotsky, 1978).

Cone and Harris (1996) affirmed these theoretical foundations of service-learning, further exploring these foundations and utilizing a number of learning, social, and cognitive theories for their proposed model of instruction. Cone and Harris (1966) stated that there is a need to provide connections between theory and practice, such as Kolb's (1984) model of experiential learning as a student-centered approach for learning theory. Kolb's cycle of learning consisted of stages in which the student first has concrete experiences followed by reflection, which is the basis for abstract concept formation. These abstract concepts are cycled again to be utilized in additional concrete experiences (Cone & Harris, 1996).

Howard Gardner, a cognitive psychologist, identified eight components of intelligence that are combined and proportioned in the process of learning. In an interview with Gardner, he asserted that human beings possess several of these intelligences, with individuals varying in their types and strengths (Checkley, 1997). Perceptions and understanding of an experience are shaped by biological, including physical and mental abilities and psychological and social conditions.

Cone and Harris (1996) utilized components of these described theories to propose a model of service-learning that they asserted is less ambiguous, linking theory to practice, for instructors. Figure 1 shows the six steps of their service-learning model.
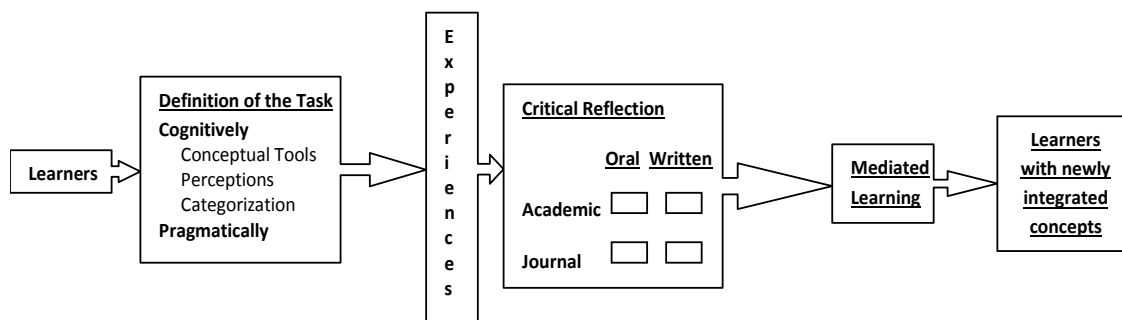
Figure 1. Model of responsible environmental behavior(adapted from Cone & Harris, 1996).

In this model, a learner begins the experience of possessing their own unique set of skills and abilities (Gardner, 1997, cited in Cone & Harris, 1996). Cone and Harris assertedthat the critical second step is pre-service training. The third component is the intellectually challenging service-learning experience followed by reflection. These researchers argue that it is essential to provide opportunities for reflection that are both written and oral. The written reflection provides the connection to academic content, increases technical literacy, and gives voice to the students' feelings or thoughts. Oral reflection can "help students test their thoughts in a marketplace of ideas" (Cone & Harris, 1996, p. 51). This model also highlights the important role of the instructor as mediator, facilitator, and guide for students as they traverse their service-learning experience. Cone and Harris suggested that educators think clearly and plan carefully about their own role in the service-learning activity. In the final step of the model, Cone and Harris (1996) concluded with the student. According to Cone and Harris, success lieswithin the increased abilities and conceptual knowledge of the student; success is not

the number of hours of service-learning or how the student feels about their service-learning experience.

Cognitive Complexity Learning Theory (CCLT), which was influenced by Dewey, proposes that cognition is complex, active, and nonlinear (Aronson et al., 2005). CCLT suggests that there is an affective component to learning—learning is influenced by feelings and values. Service-learning is by nature an instructional design that is active and varied and incorporates feelings. Aronson et al. (2005) stated that, due to its affective component, service-learning is a type of instructional design that is a very effective learning method. These researchers furthermore stated that there is support for this theory from the field of neurobiology. Instructional design that is varied and incorporates affective components may increase the demand on cognitive subsystems resulting in the development of new synapses between neurons which may increase the learner's complex thinking ability.

The Case for Service-Learning

One of strongest research studies comes from a large study of over 22,000 undergraduates that reported significant positive effects from participation in service-learning (Astin, Vogelsang, Ikeda, & Yee, 2000). This longitudinal study had both qualitative and quantitative components that measured numerous outcomes, including academic performance (grade point average [GPA], writing skills, and critical-thinking skills), values, self-efficacy, leadership, choice of a service career, and plans to participate in service after college. Astin et al. reported that when the service-learning was a part of a course, the experience had a positive benefit of all measured outcomes, except interpersonal skills, self-efficacy, and leadership. The study showed the greatest benefit of course-based service to the academic outcomes. The qualitative component of

this research study explained that the effectiveness of service-learning may lie in part due to it "facilitating four types of outcomes: an increased sense of personal efficacy, increased awareness of the world, an increased awareness of one's values, and an increased engagement in the classroom experience"(Astinet al., 2000, p. 7).

Other support for increased academic performance is provided by empirical evidence from a study in undergraduate political science courses where grades were compared between traditional courses and service-learning-based courses (Markus, Howard, & King, 1993). These authors called for replication citing their belief that "classroom instruction and community service combine synergistically to enhance learning" (p.418). Effectiveness from an academic perspective is most strongly associated with engagement and acquisition of content knowledge which this study supports. Aronson et al. (2005) noted that the study conducted by Markus et al. (1993) had a strong research design, but they described several weaknesses. The weaknesses were related to the possibility of the experimenter effect via the graduate students and the possibility of Type I errors. Both of these studies provideempirical evidence for the effectiveness of service-learning.

Increasingly higher education is reviewing its core goals with resurgence in service-learning as a third core component in addition to education and research (Thomson, Smith-Tolken, Naidoo, & Bringle, 2011). Nationally and globally, higher education is considering service-learning as a method or vehicle to prepare students as members of democratic societies (Thomson et al., 2011). More than simply service, the pedagogy of service-learning is hands-on experiential learning in the community; for some institutions,this learning parallels with their mission statements.

Service-Learning as Pedagogy and Best Practices

A study that reviewed journal articles related to service-learning and the scholarship of teaching and learning in higher education noted four major themes throughout the literature (Bowen, 2010). One common and dominant theme in much of the research on service-learning is *real-world application*. Service-learning is advocated as a pedagogical method to link course content to real and relevant situations (Bowen, 2010). Additionally, three other themes emerged: collaboration and interaction, meaning-making through reflection, and enhancement of course content. Bowen's review of the literature further noted that some of the faculty member authors of reviewed articles have the view that service-learning enhances understanding of course content more than traditional lecture-based activity. Faculty reported the opinion that service-learning engaged students with the course content through practice.

Numerous research studies have focused on the best practices of quality service-learning.Service-learning has been shown to increase academic outcomes if the activity is designed with standards of best practices (Astin et al., 2000; Eyler & Giles, 1999). Astin et al. (2000) and Billig, Root, and Jesse(2005) suggested much of the effectiveness is correlated with the professor providing connection of the service-learning experience to the course content and encouraging discussion.The National Service Learning Clearinghouse (2012) states that there are no field-wide standards for higher education service-learning. This website states that there is a significant body of knowledge of successful practices and factors in service-learning, including joint planning, a genuine sense of reciprocity, clear definition of roles and activities, careful student orientation and preparation, and consistent communication with a primary point of contact.

Standards of quality service-learning have been developed for K-12 practice. The National Youth Leadership Council(2008) released the following K-12 service-learning standards for quality practice.

- Service-learning actively engages participants in meaningful and personally relevant service activities.

- Service-learning is intentionally used as an instructional strategy to meet learning goals and/or content standards.

- Service-learning incorporates multiple challenging reflection activities that are ongoing and that prompt deep thinking and analysis about oneself and one's relationship to society.

- Service-learning promotes understanding of diversity and mutual respect among all participants.

- Service-learning provides youth with a strong voice in planning, implementing, and evaluating service-learning experiences with guidance from adults.

- Service-learning partnerships are collaborative, mutually beneficial, and address community needs. . . . (p. 1)

The standards described meaningful service to mean activities that personally engaged students and were relevant activities. The Council stated that service-learning activities should involve students having a voice in planning and implementing the activity. The service-learning activity should be linked to the curriculum (e.g. reflection, progress monitoring, diversity, and community partnership) and have sufficient duration.

Journals and reflection are considered a fundamental component of successful service-learning (Astin et al., 2000; Eyler & Giles, 1999). In a qualitative study using

reflection frameworks for university students' service-learning in elementary schools, Correia and Bleicher(2008) reported that making connections to feelings, content knowledge, and life experiences aided students in making new understandings of service-learning. In developing a set of writing prompts, such as "Today I learned . . . ." or "Today I felt . . . .," instructors of service-learning may generate reflections from students that aid in attaining the service-learning course objectives.

In the design of service-learning, it is valuable to consider the developmental stage of the students (Bradley, 2003). Bradley posited that when evaluating the positive benefits of engaging students in service-learning, one must first link objectives to his or her appropriate age and developmental stage. Student outcomes may also be affected by the degree to which students feel personally involved in the selection or choice of the service activity (Bradley, 2003). Student engagement and personal investment are more likely if the service-activity is tied closely to the course content.

Additionally, learning theories, such as Gardner's Multiple Intelligences, can guide the design and assessments of students' outcomes in service-learning activities (Bradley, 2003). Bradley (2003) related the eight intelligences and curriculum-based service-learning (see Table 1). Multiple intelligences can assist in the design and assessment of environmental service-learning activities, which was the focus of this study. Gardner suggested that students learn in a variety of specific ways and that instruction and assessment are more likely to be effective if employing a range of experiences as reflected in the theory of multiple intelligences.

Table 1

Intelligences and Curriculum-Based Service-Learning Adapted from Bradley (2003)

Type of Intelligence	Possible Curriculum-Based Service-Learning Activities	Possible Reflective Activities
Verbal/Linguistic: Capacity to use words effectively	• Interviews • Write letters • Write brochures	• Journals • Essay, expert paper • Press releases • Publicspeaking
Logical-mathematical:Capacity to reason well, the way a scientist does	• Gather and graph data related to service project. • Cross-age tutoring in math.	• Compile and present statistics and data. • Gather information needed to understand project impacts. • Surveys • Venn diagrams
Spatial: Ability to represent the spatial world internally in your mind—the way a pilot or chess player does	•Gather and graph data related to service project. •Prepare/read directions related to service project.	• Photo • Slide • Video essays • Scrapbooks • Collages, • Drawings
Bodily-Kinesthetic:Expertise in using one's whole body to express ideas and feelings	• Perform a skit based on service theme. • Learn and use sign Language. • Build a nature trail in a local park.	• Build something that reflects what was learned. • Develop and implement an exercise program for seniors.
Musical	• Tape music for visually Impaired.	• Assemble songs based on service theme.
Interpersonal: Ability to perceive and make distinctions in the moods, intentions, motivations, and feelings of others.	• Work in groups. • Cross-age tutoring in any content area.	• Write letters to senior citizensand the like. • Write a role-play or simulation based on service theme. • Train others for service.
Intrapersonal: Ability to understand yourself, to know who you are, what you can do, what you want to do, how you react to things	• Design a web page for service project. • Individualized service Project	• Keep a personal reflection journal. • Complete project activity/checklists

Table 1 (continued).

Type of Intelligence	Possible Curriculum-Based Service-Learning Activities	Possible Reflective Activities
Naturalist: Ability to discriminate among living things and non-living things	• Plant a garden of local plants to provide produce to a shelter. • Cross-age tutoring in science.	• Expert papers, essays, videos • Public speaking on service theme

Activities of environmental service-learning at the college level are most likely to involve verbal-linguistic, logical-mathematical, spatial, bodily-kinesthetic, interpersonal, intrapersonal, and naturalist components of multiple intelligences. Students who are engaged in small groups to design, implement, and reflect on service-learning activities are implementing many, if not most, of the above listed multiple intelligences.

In tracing the roots of service-learning, Harkavy and Hartley (2010) reported that there is a long history of promoting civic involvement in American colleges and universities dating back to Benjamin Franklin and the War of Independence. However, service-learning in the last several decades has been branded as an innovative pedagogical methodology in education. It is reported that in spite of its recent introduction as a practice, service-learning has gained wide acceptance and use in higher education (Harkavy & Hartley, 2010). Higher education's history of mission and purpose can be stated as three-pronged: teaching, research, and public service (Scott, 2006).Harkavy and Hartley (2010) cited that service-learning has dual functionality as an effective teaching methodology for academics and additionally serves universities' higher purposes.

Battistoni (2006) suggested that educators and researchers carefully consider the underlying conceptualization of terms, such as*service-learning*, *civic learning*, and *democratic engagement*. Literature related to service-learning should specifically utilize

the term *democracy* when referring to civic engagement or civic learning. As an example, Battistoni proposed using "education for citizenship in a democracy" (p. 6) or "educating for democratic civic engagement" (p. 9). In making the case for service-learning in higher education, Battistoni wrote:

> Students, especially those of immediate postsecondary age, come to college campuses with few experiences of lived democracy, let alone respect for their autonomy or voice, either in their schools or in their daily lives outside of school. (p. 9)

This has clear implications for the work in service-learning.In suggesting rephrasing the language of service-learning to incorporate this conceptual framework, Battistoni (2006) called for more qualitative research and research on the comparative impact of service-learning and other active pedagogies.

Theoretical Foundation

Constructivism is a learning theory that describes how learners construct new knowledge or concepts based on previous knowledge. Constructivism learning theory is a broad concept encompassing the influence of many theorists, such as Bruner (1966), Dewey (1933), and Vygotsky (1978). Constructivism emphasizes that as learners encounter new experiences they organize new knowledge within an existing mental framework. This process is active in that if the experience contradicts their framework then the framework may be remodeled. In this process the learner constructs or builds new knowledge on past experiences.Dewey (1933) had a significant impact on education. Dewey rejected commonplace authoritarian teaching, commonplace methods of that era, andpromoted his reform of pedagogical methods and curricula. His educational theories were undergirded with a foundation of the value of democracy. Dewey inferred that

learning how democracy functions "must begin at home, and its home is the neighborly community"(Dewey, 1954, p. 213).

Dewey (1938) and Vygotsky (1978) advocated for experiential learning opportunities and learner-centered science education. Kolb's (1984) theory of experiential learning proposes that learners create their knowledge as they experience it in contrast to 'receiving' fixed ideas from education. In this model learners experience or experiment with new knowledge, then construct or reinterpret knowledge through reflection. This cycle of learning generates a transition from abstract or theoretical knowledge to more concrete knowledge.

Dewey (1933) outlined the following four criteria for a project or experience to be educative:

1.Must generate interest

2. Must be worthwhile intrinsically

3. Must present problems that awaken new curiosity and create a demand for information

4. Must cover a considerable time span and be capable of fostering development over time. (pp. 217-218)

Giles and Eyler (1994b) arguedthat these criteria set service-learning squarely within Dewey's theory of learning and knowledge. Giles and Eyler further argued that service-learning promotes the personal development of an individual's character that coincides with Dewey's ideas of social philosophy on democracy and citizenship. Service-learning can serve as a pedagogical approach of constructivism.

A subset of constructivism, situatedlearning,will be considered the theoretical framework for this study. According to Lave (1988), learning should occur in a

"community of practice," which is a more realistic setting. The process of legitimate peripheral participation described by Lave and Wenger (1991) occurs when learners acquire skills in a realistic or an authentic setting and then apply new skills to the appropriate setting.Conceptually, this theory is concerned with the social setting in which learning occurs. How an individual learns in isolation is different from learning within a group setting. The community of learners plays an important role in the acquisition of new knowledge and experiences through interaction and participation. As apprentice learners acquire more knowledge and skills, they can share them with new learners who are more realistic and social in nature.

<div align="center">Environmental Education and Environmental Literacy</div>

The United Nations Educational, Scientific and Cultural Organization (UNESCO) (2112) has called for increasing environmental literacy internationally through education, including universities. In spite of a number of varying definitions of *environmental literacy*, a statement from the Tsibili Declaration of 1977 can serve as a general framework for environmental education:

> A basic aim of environmental education is to succeed in making individuals and communities understand the complex nature of the natural and the built environments resulting from the interaction of their biological, physical, social, economic, and cultural aspects, and acquire the knowledge, values, attitudes, and practical skills to participate in a responsible and effective way in anticipating and solving environmental problems, and in the management of the quality of the environment. (UNESCO, 2112, p. 1)

This statement affirms the need for education which includes knowledge of the environment as well as the behaviors and attitudes that promote environmental

stewardship. This declaration promotes an active participation by individuals and communities in solving environmental problems. Environmental service-learning can impart specific content and knowledge of ecology and the environment. However, more importantly, it may provide the development of problem-solving skills and an ethic of environmental stewardship that our world may require in solving the increasing number of environmental problems.

Roth (1992) defined *environmental literacy*with the broad adjectives of knowledge, skills, affect, and behavior. These can be specifically described as knowledge of natural systems, understanding of human impacts on the environment, and an awareness of environmental problems. Attitudes, such as respect for the environment, are encompassed within the concept. Additionally, the development of skills and critical thinking relative to the resolution of environmental problems are deemed important.

In the2005 report from the National Environmental Education and Training Foundation (NEETF) on an assessment of environmental literacy in America,Coyle (2005) concluded thatAmerican citizens are "by and large both uninformed and misinformed" (p. iv). The NEETF reported that the more education an individual possesses, the higher his or her environmental knowledge (Coyle, 2005). However, most Americans, including the more educated and influential citizens, believe they "know more about the environment than they actually do" (Coyle, 2005, p.vii).

A framework for assessing environmental literacy was developed by the North American Association for Environmental Education(NAAEE) (2011). This association describes its objectives as environmental education for children and adults that leads to environmentally literate people. This framework, developed by researchers, educators

and assessment specialists, provides descriptions of competencies, knowledge, and

dispositions (NAAEE, 2011). Competencies are skills or abilities, such as the following:

- Identify and investigate environmental issues

- Evaluate, analyze and make personal judgments about environmental issues

- Create and evaluate plans to resolve environmental issues. (p. 3)

The NAAEE describes the knowledge related to environmental literacy as

follows:

- Physical and ecological systems, i.e., cycles of matter and energy, adverse

  impacts of humans on these systems, humans as agents of protection of these

  systems

- Social and political systems that include civic participation and practices

  associated with environmental problem-solving

- Knowledge of a variety of environmental issues

- Civic participation and community service intended to preserve or improve

  the environment. (p. 3)

Dispositions in the NAAEE (2011) framework for assessing environmental

literacy are described as behaviors and motivations to participate in public deliberations

about environmental issues and include the following: (a) sensitivity or positive feelings

toward the environment; (b) attitudes that are favorable toward environmental issues; (c)

personal responsibility to avoid or reduce behaviors with negative environmental impact;

(d) self-efficacy, the belief that individuals will be able to influence or bring about

environmental change; and (e) motivation and intentions related to attitudes toward

environmental issues

Environmental literacy, as described by the NAAEE, includes environmentally positive

attitudes, behaviors, and knowledge of ecological systems and environmental issues

(2011).

Kennedy, Beckley, McFarlane, and Nadeau (2009) reported in a nationwide

survey of Canadian citizens that increases in environmentally positive values did not

translate to an increase in environmentally positive behaviors. Kennedy et al. discussed

and reported that there is an increase in environmentally positive values and beliefs in the

Canadian population; however, there is a gap between these values and self-reported

behaviors. Kennedy et al. explored the self-reported values of these participants with a

majority adhering to the New Ecological Paradigm (NEP) rather than the Dominant

Social Paradigm (DSP) that suggested more positive environmental values with 72.3%

reporting a gap in their actions or behaviors related to consumer and lifestyle choices.

Kibert (2000) analyzed the relationship between knowledge, attitudes, and

behaviors of environmental literacy in undergraduate students at the University of

Florida. The University of Florida, at that time, did not have any institutional

environmental literacy programs. Kibert (2000) reported that knowledge had an

insignificant relationship with behavior and a weak correlation with attitude ($r = .232$ and

$r^2 = .211$, respectively). Possessing knowledge of environmental problems does not insure

that attitudes and more environmentally conscious behaviors increase (Hungerford &

Volk, 1990; Kibert, 2000).Additional studies from the United States reported this pattern

in Florida college faculty (Green, 1997) and citizens in Pennsylvania who exhibited a

higher environmental attitude than behaviors (Scott&Willits, 1994), therebyreflecting

environmental literacy. International studies of youth in Australia (Connell, Fien, Lee,

Sykes, & Yencken, 1999) and Dutch youth (Kuhlemeier, Van Den Bergh, &Lagerweij,

1999) found attitudes higher than behavior scores. Citizens of Germany and Switzerland reported scores of perceived attitudes higher than personally reported environmentally positive behaviors(Diekmann& Preisendorfer,1998).

In a report released by the State Education and Environment Roundtable (SEER), this nationwide study found that using the environment as a framework in K-12 education increased student achievement and academic engagement and reduced problems with discipline and classroom management (Lieberman & Hoody, 1998). In this study, the EIC (Environment as an Integrating Context) utilized environment-based interdisciplinary themes with hands-on learning and project-based activities.

Monroe (2003) applied behavioral theories to guide conservation agencies on strategies that encourage environmentally responsible behaviors and increase environmental literacy. The most applicable to educational settings is the Environmental Citizenship Behavior Framework. Hungerford and Volk (1990) described this framework for building environmental literacy. In general, Hungerford and Volk suggestedthat there are three categories of variables which interact to predispose an individual to environmentally responsible behavior: environmental sensitivity or an empathetic perspective, knowledge of and a personal investment in environmental issues, and empowerment variables in which individuals believe they have the skills to help solve environmental problems (Monroe, 2003). Monroe acknowledged the difficulty of measuring environmental literacy but suggested that project-based learning programs can enhance self-efficacy which may serve as a piece of environmental literacy. Self-efficacy as described by Bandura (1994) is the measurement or belief of an individual that they have the capability to control or produce an outcome. This belief may encourage one to act.

Monroe (2003) suggests that participation in project-based environmental problems, specifically service-learning projects, has the capacity of promoting self-efficacy, knowledge, and problem-solving skills and can allow students to see the results of their activity. In Monroe's estimation, these experiences can have the power to change behaviors to more environmentally responsible behaviors. Coyle (2005) supported this viewin the NEETF publication, citing that outdoor learning, place-based learning, and community service have great potential for real behavioral changes to more environmentally responsible actions.

The responsible environmental behavior model was developed by Hines, Hungerford, and Tomera (1986-1987) by conducting a meta-analysis of 128 previous studies on prediction of environmental behavior. This model highlights the need for environmental literacy pedagogy that reflects the interactions producing environmentally responsible behaviors. The model of responsible environmental behavior, shown in Figure 2, illustrates the multiple variables that could predict responsible environmental behavior.
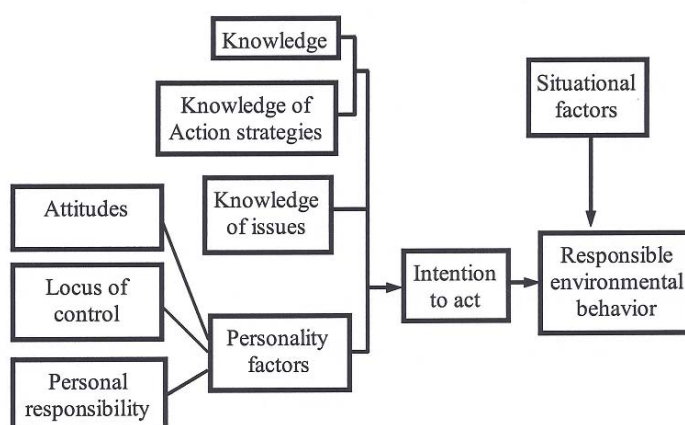
Figure 2. Model of responsible environmental behavior (Hines et al., 1986-1987).

Content knowledge, knowledge of issues, and knowledge of available action strategies also interact collectively with individual personality factors that, in turn, are affected by additional components. Components that can affect personality factors include attitude, locus of control (self-efficacy), and personal responsibility. Collectively, these components exert an effect on the intention to act in an environmentally responsible manner. This intention is affected by the specific situation in which an individual has pro-environmental skills. If the situation changes,then the individual may not adapt the behavior or action to the new situation.Hence, there is a need for experience and knowledge of effective environmental solutions.

Kaiser, Wolfing, and Fuhrer (1999) utilized an abbreviated version of the theory of planned behavior (Ajzen, 1991), which was modified by Hines et al. (1986-1987), to study environmental attitude as a predictor of ecological behavior. In this study, two ideologically different Swiss transportation associations were surveyed, and the questionnaire data showed significant outcomes supporting the notion that environmental knowledge and values (attitude) are preconditions of environmental behavior. Environmental knowledge and environmental values explained 40% of the variance of ecological behavior intention. Ecological behavior intention predicted 75% of the variance of general ecological behavior (Kaiser et al., 1999).

Hines et al.(1986-1987) reiterated that knowledge is important; however, learners must also possess knowledge of courses of action and effectiveness of those courses of action under changing situations. Hines et al. proposed that environmental educators should address knowledge, attitude, and skills, stating that, "Approaches which address both affective and cognitive experiences and which provide individuals with opportunities to develop and practice those skills necessary to lead to environmental

action must be developed and implemented in our schools' systems" (1986-1987, p.8).

Individuals with knowledge of environmental strategies and practice with these strategies

may increase environmentally responsible behaviors more than those individuals with

only knowledge and pro-environmental attitudes. Traditional educational methods may

provide knowledge and affect attitudes related to environmental literacy; however,

service-learning may enhance knowledge, attitude, and experience with effective

environmental strategies.

In association with the NAAEE, the Environmental Literacy Assessment

Consortium (ELAC) undertook the task of developing national standards for

environmental literacy. Out of that work the Consortium described four broad divisions

within the framework: (a) the cognitive dimension (knowledge and skills); (b) the

affective dimension (attitudes, environmental sensitivity, and values; (c) the efficacy

beliefs (locus of control and assumption of personal responsibility); and (d) the

involvement in environmentally responsible behaviors (Green, 1997). The model for this

study, the Environmental Literacy Framework is shown in Figure 3.

| Knowledge | — | Attitudes | — | Behaviors |
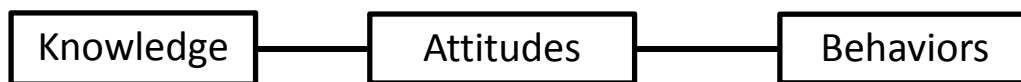
Figure 3. Modified Environmental Literacy Framework (Kibert, 2000).

Using this framework, the Wisconsin Center for Environmental Education

(WCEE) developed outcomes that, in turn, were utilized to develop the 1994 Wisconsin

High School Environmental Survey. The survey used for this study is a modified version

of the Wisconsin High School Environmental Survey. This modified version has been used for adults and used in a number of studies (Green, 1997; Kibert, 2000).

Environmental Service-Learning

Service-learning can be an excellent pedagogical strategy for environmental literacy and environmental education (Furco& Root, 2010; Haines, 2003; Handa et al, 2008; Lieberman & Hoody, 1998; Newman, 2008). As defined by Roth (1992), *literacy*is "the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems" (p.10). Service-learning, along with a foundation of ecological content, can provide an opportunity for 'hands-on' experiences that may increase knowledge, skills, and problem-solving skills and affect attitudes related to environmental problems. Packer (2009) conducted a mixed methods study of environmental service-learning in an introductory botany course at a southern liberal arts university comparing traditional laboratory experiences with environmental service-learning. Using the New Ecological Paradigm (NEP) survey scores and reflective writings suggested that students felt that environmental service-learning assisted in meeting course objectives, impacted student learning positively, and led to pro-environmental attitudes. Monroe (2003) suggested that conservation-minded behaviors can be encouraged by education and through experiencing problem-based environmental problem-solving.

In one qualitative study on the effects of environmental service-learning in middle-school students, comparisons between students with environmental service-learning and those without environmental service-learningshowed students with service-learning had a greater understanding of environmental issues and felt empowered to act in environmentally responsible behaviors (Hobart, 2010).A study of environmental

service-learning at a large southern university reported students' environmental knowledge, views, and attitudes increased after participating in voluntary service activities (Leege & Cawthorn, 2008).

However, not all studies have shown a measurable benefit. In one large study of middle-school children engaged in environmental service-learning, Covitt (2003) concluded that personal goals or motives played a role in whether students intended to engage in environmentally responsible behaviors. This large study failed to find a correlation between environmental service-learning and responsible environmental behaviors noting, however, that many of the service-learning projects were poorly designed and failed to meet standards of best practices. The project specifically reported lack of opportunity for student decision-making and reflection. Covitt (2003) suggested that it is difficult to measure the success of service-learning if these specific elements are missing. Covitt further stated the need for empirical evidence specifically related to the how and why service-learning is successful. The lack of similarity in service-learning experiences and poor design is common criticism of studies involving service-learning (Billig et al., 2005).

Studies that assess environmental service-learning are fraught with a number of challenges, such as differences in service-learning design, assessment, and variable quality. England and Marcinkowski (2007) investigated the environmental service-learning programs in high schools and colleges in Florida, citing that there is limited research on environmental service-learning, with most studies of environmental service-learning generating theoretical and descriptive works. The researchers received environmental service-learning survey responses from teachers in 25 secondary schools and 18 colleges. England and Marcinkowski reported a great variety in the design of

environmental service-learning relative to a number of factors. For example, some environmental service-learning was voluntary and others were required. Assessment type and reflection requirements were also reported as variables. Even so, teachers in Florida reported increases in growth and learning in their students as a result of environmental service-learning experiences (England & Marcinkowski, 2007).

MacFall (2012) stated that there is less quantitative analysis of environmental-service-learning at the college level than qualitative analysis, some of which is anecdotal. In MacFall's longitudinal study of the impact of service-learning in environmental studies, postgraduate survey respondents reported long-term positive outcomes on measures of knowledge, motivation, and skills related to environmental issues.

Increasingly, universities are being called upon to educate students pursuing a variety of majors, such as education, business, and management in concepts related to environmental issues (Esa, 2010; Haines, 2010; Rands, 2009). Rands (2009) recommended campus-based environmental service-learning as a way for management students to acquire knowledge, skills, and pro-environmental attitudes. Rands (2009) further noted the lack of formal studies on the effects of campus greening efforts. Preservice science teacher preparation is increasingly utilizing environmental service-learning as an educational tool internationally and nationally (Esa, 2010; Handa et al., 2008).

Environmental service-learning could provide hands-on learning experiences that can be implemented in the ecosystems or communities surrounding schools. Lieberman and Hoody (1998) described their perspective of environment as an integrating context (EIC) as follows:

EIC-based learning is not primarily focused on learning about the environment nor is it limited to developing environmental awareness. It is about using a school's surroundings and communities as a framework within which students can construct their own learning, guided by teachers and administrators using proven educational practices. (p. 1)

Since the ecosystems surrounding schools and their communities vary as dramatically as the nation's landscape, the term *environment* may mean different things at every school. It may be a river, a forest, a city park, or a garden carved out of an asphalt playground.

Sobel (2004), an advocate for "place-based education," described this pedagogy which reinforces a connection between students and their 'place' that is close to home. Sobel cited research and anecdotal evidence that using the environment as the integrating context through place-based education increases students' environmental stewardship and is an effective method of meeting state and national academic standards. Sobel encouraged teachers to be attentive to the needs or concerns that are unique to each school and its surroundings. Teachers can strive to connect environmental education with campus or community-based projects. A place-based environmental service-learning project can serve as a successful pedagogy that develops environmental concepts and stewardship.

Justification for Campus-Based Environmental Service-Learning

Newman (2008) was an advocate for campus-based service-learning for universities and colleges that are increasingly focusing on energy conservation and sustainability. Sustainability is the goal for ecological, social, and economic systems that can last over the long-term (Cunningham & Cunningham, 2011). As graduates enter the

workforce, despite their major, they will be faced with the reality of environmental problems. Citizens in the workforce will need to develop strategies for reducing energy consumption, recycling, and habitat loss. Newman stated that traditional teaching methods of lectures, discussions, and reading literature alone will not provide the necessary skills development. Newman proposed that service-learning is a heuristic pedagogy that can practically prepare students for these environmental challenges. Heuristic teaching methods encourage a student to learn, discover, or solve problems on their own. A definition and description of service-learning as a pedagogical method were described by Markus, Howard, and King (1993):

> It is first and foremost a teaching methodology, more than a values model or a leadership development model or a social responsibility model. Second, there is an intentional effort made to utilize the community based learning on behalf of academic learning, and to utilize academic learning to inform community service. This presupposes that academic service-learning will not happen unless concerted effort is make to harvest community based learning and strategically bridge it with academic learning. Third, there is an integration of the two kinds of learning—experiential and academic; they work to strengthen one another. And last, the community service experiences must be relevant to the academic course of study. (p. 411)

Newman (2008) proposed a model of service-learning for sustainability in which the university or college campus is used as the source for the projects, where the campus is subject and partner. Newman promoted carefully designed service-learning projects with defined learning outcomes, required, reflection, and linked to the academic content. Furthermore, Newman defined service-learning as not volunteerism, internship, or field

education. This model of service-learning for sustainability suggests that projects can be ongoing and dynamic from year to year and address issues, such asenergy conservation, recycling, and reduction of use of harmful chemicals. To be effective, this model must consist of a partnership among the students, faculty, administrators, and staff.

Today's practitioners of biology education are aware that knowledge acquisition is more than conveying information or facts from teacher to student. Practitioners have a suite or arsenal of pedagogical tools from which to choose, such as active learning methods, inquiry, manipulatives, cooperative learning strategies, visualizations, and dialogue. Service-learning is an additional pedagogical tool that can be utilized to increase academic knowledge but may have a greater impact on changing attitudes and behaviors than other methods.

If higher education professes the goals for developing citizens who are concerned and involved in society's issues, then evidence suggests that service-learning has a positive influence on the values of undergraduate students (Astin et al., 2000; Eyler & Giles, 1999). Colleges and universities are increasingly focusing on the values of students and specifically the institutional mission statements. Conville and Weintraub (2001) stated that service-learning "enables colleges and universities to move to a new and more powerful level of commitment to their institutional goals" (p. 9). Service-learning is an opportunity for students to have real and relevant experiences beyond the textbook that could impart a sense of purpose for environmental literacy and engage students with the complex environmental issues of our times (see Figure 4).
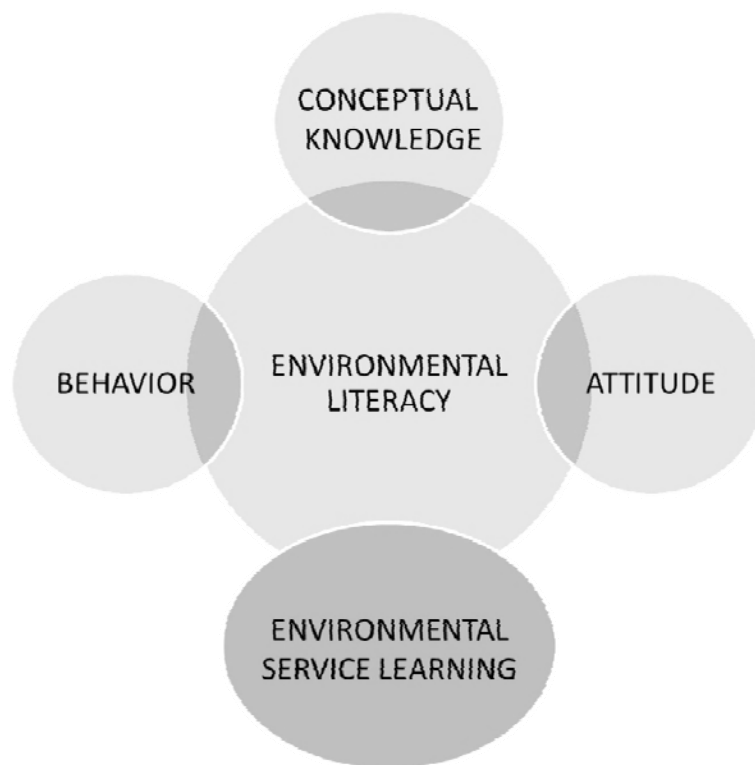
Figure 4. Model of environmental literacy.

CHAPTER III

METHODOLOGY

The purpose of this study was to investigate the role of service-learning in college students' environmental knowledge, attitudes, behaviors, and environmental literacy. For this study, environmental literacy is indicated by students' demonstrated understanding of ecological principles, their affective attitudes toward environmental problems, and their pro-environmental behaviors.

Research Design

This study utilized qualitative and quantitative data analysis. Data were collected in a concurrent mixed methods approach in which quantitative data and qualitative data are collected concurrently (Creswell, 2009). The design for the quantitative component of the study utilized a quasi-experimental repeated measures approach. Participants were randomly selected into two groups by an independent number drawing. After participants were assigned to one of the two groups, groups were randomly selected by number draw to environmental service-learning project or other active learning activities. Classes had similar treatments but at different time periods in the course. All students took the same pretest at the beginning of the trimester. Participants' environmental knowledge, attitudes, behaviors, and literacy were measured with an environmental literacy instrument. Classes were randomly divided into two groups. One group will began a 4- to 5-week environmental service-learning project followed by the posttest. While the first group engaged in the environmental service-learning project, the second group engaged in assigned laboratory and class activities. The groups were then alternated in the second half of the course. All students took the posttest immediately upon completion of the environmental service-learning project. Figure 5 illustrates the research design.
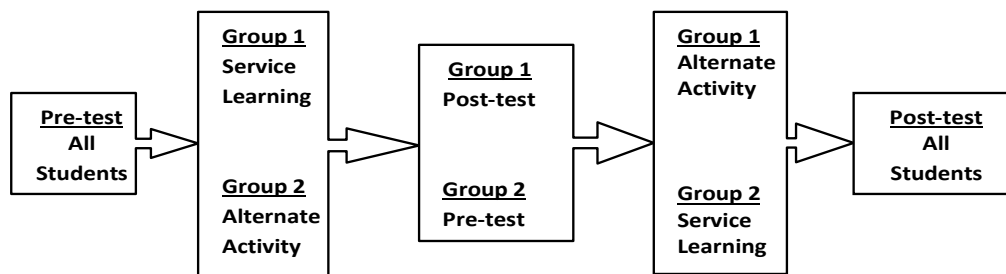
Figure 5. Research design model.

The environmental service-learning and assigned activities were graded and similar in time requirements and content for both groups.The no-service-learning activity did not have the group dynamic or reflection component which could avoid similar treatment to service-learning.All students, whether engaged in the first or second service-learning activity, had the same lectures, assigned readings, laboratory, and field experiences. Qualitative data were collected from the service-learning portfolios, journal reflections, and final anonymous reflections that were required from all course participants. The researcher was the instructor for the course. The participants, instruments, procedures, instructional treatment, and analysis are described below.

<div align="center">Participants</div>

Participants in this study were undergraduate students enrolled in an environmental biology course at a private Christian university located in south Mississippi. Environmental Biology is a four-semester hour course with a laboratory component. This course does not have any prerequisites and can satisfy the university'score requirement for a laboratory science course. Participants represented both non-biology and biology populations of the university with diversity in gender and

age. Demographic data werecollected to determine participants' gender, age, and college major.

<p style="text-align:center">Instrumentation</p>

Pretests and posttests were conducted using instruments directed toward the research questions. The Environmental Literacy Survey, a version of the Modified Wisconsin Environmental Survey developed by Green (1997) and Kibert (2000) for use with adults that measures environmental literacy, was used in this study (see Appendix A). Permission to use this instrument was obtained from Kibert via email correspondence (see Appendix B). The modified version of this instrument used in this study took approximately 20 to 30 minutes to administer. The modified Wisconsin Environmental Survey (WES) consists of three subscales: Affective, Behavior, and Cognitive. Kibert (2000) renamed each section to reduce the use of technical jargon toAttitude, Behavior, and Knowledge, respectively. Each subscale is a horizontal numeric scale with the least preferred response (1) being assigned zero and the most preferred response (5) with a value of 4. A higher score on each subscale is designed to reflect theestimate of environmental literacy.

Subscales

Environmental attitude. The Affective (Attitude) subscale consists of the sum of 15 responses regarding attitude toward the environment and efficacy beliefs. The highest possible score is 60, and the lowest possible score is zero. Some of the responses were reverse coded as some of the statements are worded with the most environmentally appropriate answer on one end of the scale and at other times at the opposite end of the scale.

Environmental behavior. The Behavior subscale score is the average of 15 responses on personal behavior that affect the environment. Highest frequency of demonstrated environmental action (5) is a score of 4, and scored and lowest frequency of action (1) is zero. The lowest possible score is zero, and the highest possible score is 60.

*Environmental knowledge.*There are 15 questions in the Cognitive (Knowledge) subscale component of the WES with responses related to knowledge of ecology, environmental problems, and action strategies. A score of 4 is assigned for correct responses and zero for incorrect responses. The highest possible score is 60, and the lowest score possible is zero.

Each subscale is added together to estimate environmental literacy. The higher the composite score, the higher the estimated level of environmental literacy. Composite lowest score is zero, and the highest is 180.

Instrument Validity

This survey's reliability and validity are well-documented (Green, 1997; Kibert, 2000). The content of the Environmental Literacy Survey is based on the framework developed by the Wisconsin Center for Environmental Education and the National Association of Environmental Education Guidelines. The Wisconsin Center for Environmental Education has tested the instrument for validity of construction and content. The reliability of the instrument was reported by Green (1997) in which the coefficient alpha for the Affective subscale equals 0.91; for the Behavior subscale the coefficient alpha equals 0.88; and coefficient alpha for Cognitive subscale equals 0.84.

Procedure

Permission to conduct this research was requested and obtained from The University of Southern Mississippi's Institutional Review Board (see Appendix C). Potential participants in this study were enrolled in Environmental Biologyduring 2012. The procedure described was used for all sections of the course. The instrument was administered by an in-class proxy. A proxy was used to administer the instrument so that study participants would avoid the perception of bias or coercion on the part of the researcher since the researcher was also the instructor of the course. The study was described as an investigation of the role of service-learning on the participants' environmental knowledge, attitudes, behaviors and environmental literacy. After a brief oral presentation (see Appendix D) explaining the study, written consent was obtained from the participants (see Appendix E). In order to preserve participants' identity, the researcher did not have access to the students' informed consent forms. Participants were allowed to withdraw from the study at any time without prejudice.

After the oral presentation and informed consent was obtained, participants completed the first part of the packet that included an individualized code number based on their personal responses to specific questions. This name-numeric number became the students' code for the remainder of the study. The questions were of the nature that it was not possible for the researcher to link the code to a specific participant based on the available information to the researcher. The same instructions and questions accompanied the instrument package each time the instrument was administered. This procedure ensured that the scores of participants who dropped out of the course were eliminated from the statistical analysis and results of the study.

The date and demographic information wererecorded with each administration of the instrument.Demographic information included gender, age range, and college major.

The total time of oral presentation, informed consent, and administration of the instrument was approximately 30 minutes. The course, Environmental Biology, served as the treatment in this study and is described in detail in the Instructional Treatment section below.

Instructional Treatment

Environmental Biologyis a four-semester hour credit, one-trimester course that satisfies the core laboratory science requirement for a Bachelor of Science degree at the university where the study was conducted. Furthermore, this course can also be used by biology majors for degree requirements. This course was offered during the spring and summer 2012 trimesters. The researcher designed and instructed the course.

General Course Overview

This course is an introduction to the basic principles of environmental biology, ecology, and the relationship between humans and the natural world. The focus of this course was to introduce students to concepts of basic ecology and current environmental problems. One of the specific objectives of the course related to the development of students' understanding of the impact of human activities on ecosystems. Students were encouraged to critically evaluate environmental issues and explore potential solutions to environmental crises. The course was designed to educate students about environmental problems and to foster environmental stewardship. Activities and assignments were structured to present the notion that humans can create solutions through intentional action that can improve the health of natural systems. An abbreviated syllabus can be found in Appendix F. Class instruction consisted of lectures, short videos, class discussions, and small group activities.

Readings and resources. The required textbook for the course was *Principles of Environmental Science: Inquiry and Applications* (Cunningham & Cunningham, 2011). The lead author, an emeritus professor at the University of Minnesota, has written a number of textbooks and numerous research articles. The second author is an associate professor of geography, teacher, and researcher of environmental science at Vassar College in New York. The textbook is current in its content, utilizing case studies that highlight environmental problems. The authors used an integrated or interdisciplinary approach to the environmental sciences and emphasize the human impact on natural systems. Specifically, Cunningham and Cunningham (2011) presented the material with a balanced perspective relative to economic, social, and environmental perspectives to promote critical-thinking skills.

Additional reading assignments consisted of excerpts from a variety of works and perspectives relative to environmental science including E. O. Wilson, Aldo Leopold, and Rachel Carson. Students were assigned to write a two-page (APA style) critical review of these authors.

Laboratory assignments. The laboratory assignments consisted of laboratory activities and field work. Students conducted water quality testing, biodiversity sampling of habitats, air pollution testing, and field trips to local national parks and rivers.

Service-learning design. A service-learning project was designed to have sufficient length for student engagement in hands-on activities related to environmental problems in the community (see Appendix G). Service-learning of one to 2 months in duration has the highest academic impact (Billig et al., 2005). Dewey's four criteria for educative experience, Gardner's multiple intelligences theory, and quality practice of service-learning were used as guidelines in the development of the service-learning

project. Students were divided into groups of 4 to 5 students. These small groups separately brainstormed ideas for service-learning projects that were carried out within a 4-week time period. The instructor/researcher's approval was obtained prior toinitiation of the project.

The environmental service-learning project required students to cooperate, engage creatively, and employ problem-solving and critical-thinking skills. This design may decrease threats to validity through diffusion of treatment and resentful demoralization. Students engaged in environmental service-learning were in separate locations during planning and implementation. Furthermore, all students were required to engage in environmental service-learning, which reduced issues of self-selection or resentful demoralization.

Students' grades on the service-learning project were assessed by a group portfolio of project that included project objectives, design, a log of meetings, and documentation of the final project such as photographs. A final requirement was a group oral presentation and portfolio sharing. A component of students'individual grades wasa composite score for self-evaluation and peer member evaluation on participation. Individual grades were also assessed via a personal project written reflective journal.

Reflection is a critical component of service-learning and should include the ABCs of reflection (Welch, 1999). The *A* in the ABCs of reflection stands for the affective domain or involves feelings and emotions (Boise State University Service-Learning, 2012). The *B* in the ABCs of reflection represents behavior, actions, or skills that the student might apply or utilize. The *C* is connections to the course content, i.e., connection to the course content and probes whether the student understands the concepts of the course. Reflection questions for the students' journal probed students'

understanding of connection to the course content and concepts (the *C* for content of the ABCs). Additional reflection questions probed students' feelings (the *A* for affective in the ABCs) and skills or behaviors learned (the *B* for behavior in the ABCs).

Each service-learning group was provided a list with possible environmental project ideas from which they could choose or design their own. However, the instructor's approval was required prior to planning and implementation. All environmental service-learning projects were to take place at the university or the adjoining wooded property.Each service-learning group decided on a specific project to design and complete. During the two trimesters, the students' choices for projects included the following:

1. Investigated requirements and organized plans for certification of Wildlife Habitat through National Wildlife Federation (NWF).

2. Designed, built, and planted a butterfly garden.

3. Researched appropriate design for barn owl, screech owl, blue bird houses, including building and placing the bird houses.

4. Inventory of plants and animals located on the 390 acres, biodiversity.

5. Researched and implemented a campus recycling program.

Description of service-learning projects. The randomly selected groups consisted of 4 to 6 students per group. Each group met separately to brainstorm ideas for their projects. The instructor met with each group providing guidance and feedback relative to the ideas that were generated in the individual group discussions. The instructor suggested modifications of the project ideas which kept the projects within the parameters of quality service-learning and the timeframe of the course. Initially, some

project goals were too broad or too narrow. Each project ultimately was approved by the researcher/instructor.

One of the groups chose to research and implement a campus recycling program for staff, faculty, and students. Per instructions and guidance from the researcher/instructor, the group initially set goals and objectives. Members divided up tasks including researching how to set up campus recycling and contacting the local waste management company. After completing their initial tasks, the students contacted the dean of the campus and, in a subsequent meeting, made a presentation for the administrative approval. After obtaining administrative approval, the group designed educational flyers and recycling bins on campus. Currently, the project is on hold pending construction of a storage facility on campus (see photographs in Figure 6).

Members of the campus biodiversity project set their goal to begin catalog of the various plants and animals on the university campus and adjacent wooded acreage. They utilized a variety of reference materials including botanical keys, guidebooks of animals, and animal scat to research the native biodiversity. The campus biodiversity group conducted a tree biodiversity count by examining the number of trees in a cordoned plot and extrapolating the number of trees on the university property. Amphibian identification was made utilizing online recordings of vocalizations. Nighttime photography was utilized to capture images of nocturnal wildlife. Tracks and scat were identified including nonnative wild pigs. The group produced a natural history booklet and PowerPoint presentation for educational purposes (see Figure 7).
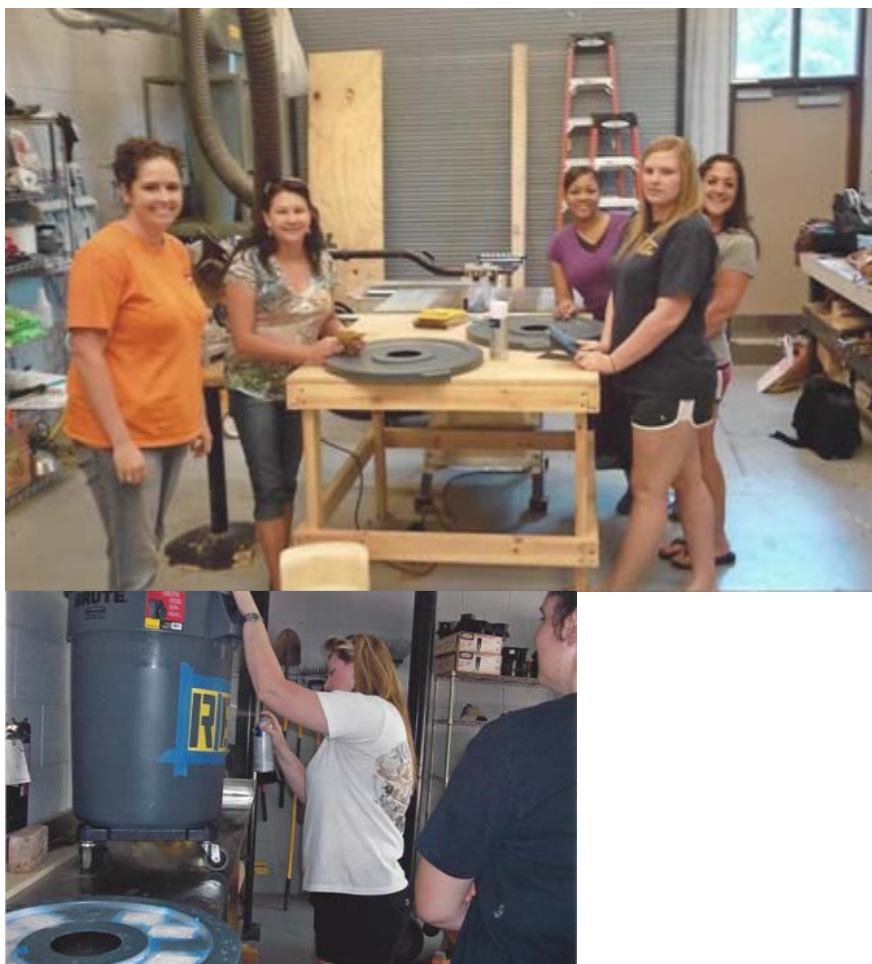
Figure 6. Campus recycling program.
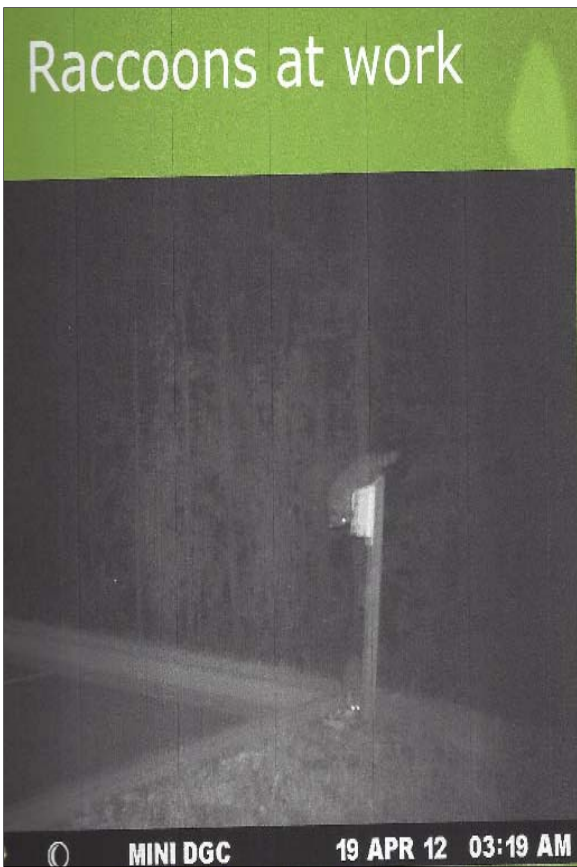
Figure 7. Campus biodiversity project.

A number of groups initially met individually to plan a variety of projects that overlapped somewhat. One group, after researching how to increase wildlife habitats on campus, presented a coordinated overall plan with each smaller group subdividing the separate goals. The overall goal was to create a certified wildlife habitat on campus. They reported that the National Wildlife Federation identified four basic elements required for a wildlife habitat including water sources, food sources, cover, and a place to raise young. Each group selected specific tasks to complete separately but united in the overall plan and goal. A butterfly garden was designed and planted with plants, bird bath, and toad shelters. Bird feeders were built to species specifications and placed on campus. Bird feeders and hummingbird feeders were acquired, placed, and maintained by the students (see Figure 8). Butterflies and birds were attracted to the habitats upon introduction. The students were surprised and delighted to see butterflies on recently placed plants, native birds on feeders, and within a week a pair of bluebirds had built a nest and laid eggs in the bluebird house.

Students' documented their service-learning projects with meeting minutes, design plans, and photographs that were collated into a group portfolio. Additional documentation was collected as personal reflections. See Appendix H for selected photographs of the different service-learning projects.

*Final anonymous service-learning reflections.*At the end of the trimester, students were provided a sheet with three prompts for a final anonymous reflection. These final reflections provided a source of data for the researcher that was compared to the journals for validity of results without undue bias. The three questions or prompts were as follows:

Figure 8. Campus butterfly garden project.

1. Are there concepts/topics you learned from the service-learning experience that you would not have learned in the classroom?

2. Are there concepts you learned in class that you understand better because of service-training?

3. How would you describe your overall experience with service-learning?

Non-service-learning activity design. The groups not engaging in service-learning were assigned an endangered species project and an independent field activity to the Sandhill Crane Refuge (see AppendixesIand J). These activities were designed to encourage students' to investigate endangered species and visit a refuge that provides protection for an endangered species. Simultaneously, the service-learning group

included planning and carrying out their projects. The separation of the two groups,

service-learning from non-service-learning, minimized contact between the groups and

allowed the instructor to monitor both group activities. The endangered species project

was a modification of Endangered Species and Biodiversity: A Classroom Project and

ThemeActivity (Lauro, 2010) in which students prepared a fact sheet handout and

PowerPoint presentation on an endangered species.

The Sandhill Crane Refuge activity, a self-guided field experience at the

Mississippi Sandhill Crane Refuge off Interstate 10 in south Mississippi, was designed by

the researcher. This activity required students to answer pre-field trip questions and then

tour the Refuge. Students were guided to visit the Visitor's Center and view the museum

exhibits and video. The students were given specific questions designed to connect the

museum, video, and field experience to the course content. The Scavenger

Huntcomponent of the assignment directed the students to walk the C. L. Dees Wildlife

Trail at the Refuge and take photographs of specific organisms using a digital camera or

smartphone. Answers to the field questions and photographs were turned in for

assessment.

Student assessment. Assessments were both formative and summative. Students

were assessed on lecture material by three multiple-choice style examinations. Written

reviews of selected reading assignments, the service-learning activity, reflection,

endangered species project presentation, field experiences, and laboratory assignments

were also assessed.

Data Analysis

Data collected for analysis consisted of the scores that measured knowledge,

attitudes, and behavior related to environmental literacy. Administrations of the survey to

the subjects consisted of all three subscales. The data were collected from two courses

during consecutive trimesters. All trimesters were the same duration (10 weeks)

regardless of term. Generally, the class sizes for this university can be estimated to be

between 15 and 20 students, resulting in a total sample size of 30 to 40 students. Utilizing

a repeated measures research design,whereby half of the students engaged in service-

learning the first part of the course and then switched the second group to service-

learning in the second part of the course, compensated somewhat for the smaller sample

size.The second administration of the survey was the posttest for the first service-learning

groups and the pretest for the non-service-learning groups.

Random selection of individuals into service-learning and no-service-learning

groups and the random selection of which groups would engage in environmental

service-learning should meet the assumption of independence of groups. Service-

learning was the same length in both trimesters. To determine any prior differences

between the groups of each trimester, it was possible to use the pretest scores as a

covariate to determine if the groups were generally equivalent for environmental literacy

at the onset of the study.

Before analyzing the results of the survey, demographic data consisting of age,

sex, and college majors and minors were summarized to provide a summary profile of the

study participants. The survey responses were entered into an Excel worksheet coded for

responses on the horizontal numeric type scale for the attitude and behavior subscales and

the correct answers for the knowledge subscale. Means and standard deviations of the

results of the three Environmental Literacy subscales were calculated comparing the

pretest scores of all groups with posttest scores of groups as they completed the

environmental service-learning component of the course. Repeated measures ANOVA

were employed to detect any differences in pretest groups relative to
trimesterexperimental and control groups. The three subscale scores were compiled into
a composite Environmental Literacy score that served as the dependent variable for this
study and were separately analyzed from the three subscale score analysis, which may
have served as three additional dependent variables.

Qualitative data from students' journals, group portfolios, and final reflections
were predetermined for coding utilizing a deductive approach by the researcher into three
themes or categories: environmental attitudes, behaviors or skills acquired, and
knowledge related to environmental biology.These categories related to the research
study questions. These themes were aligned with the subscales of the Environmental
Literacy Survey. Qualitative data were evaluated by typological analysis that is useful
with a constructivist framework for research (Hatch, 2001). Typological analysis utilizes
predetermined categories that in this study were based on research questions. Categories
or themes related to environmental literacy were used for processing the data. The
qualitative data were systematically hand-coded by the researcher/instructor using
separate colored coding schemes for *attitude, behavior, knowledge*, and *environmental
literacy*. Each individual student's journal, final reflection, and group portfolios was
analyzed for statements related to attitude or affective components of the environmental
service-learning project and highlighted or flagged by color coding with a pink marking
scheme.

Attitude themes were grouped from students' specific statements related to
feelings, emotions, or reactions. Other color schemes were used to flag or highlight
statements that reflected behavior, content knowledge of environmental biology, or
finally environmental literacy. Behaviors or skills coding reflected actions, activities, or

project environmental strategies. Content knowledge was coded by specific course content related to the lecture material. Environmental literacy statements were grouped by a broader theme or statement that can be interpreted encompassing all three of the former groups.Additionally, journals were reviewed holistically for emerging themes.

In reviewing all datathe researcher/instructor categorized statements that were not specific to the previously described categories. These reflections were considered an emerging theme is a common thread or content was expressed in half of the students' statements.The following elements of trustworthiness and credibility of qualitative data were addressed (Creswell, 2009). A qualitative researcher should be mindful of the four elements of trustworthiness: credibility, transferability, dependability, and confirmability (Shenton, 2004). Credibility of the data or research wasincreased by the researcher's use of established research method, peer scrutiny, previous research examination, thick description of typology, and triangulation. For this study there was no sampling of participants as all students were required to engage in service-learning and journaling as a requirement for the course. Triangulation involved the use of three different documents and comparison with quantitative data. This approach resulted in data collected in 36 journals, 36 final anonymous reflections, and 7 group portfolios.

A second criterion of trustworthiness is transferability, whereby the findings of the study can be applicable to other populations or situations (Shenton, 2004). Transferability of this study was addressed by providing detailed description of the research, participants, time period of the study, description of environmental service-learning projects. and photographs of the projects.

Dependability is a third element of trustworthiness that involves repeatability of the same research study. Descriptions of the methodology of this study may provide a

level of dependability of the findings. Additionally descriptions of the methodology may

support the final criterion of qualitative data—confirmability (Shenton, 2004).

Confirmability should also address investigator bias. In this study, the

instructor/researcher held the view that environmental service-learning could be a method

for increasing environmental literacy, which was the premise of the study. Triangulation

of results from multiple data sources may increase confirmability of the study.

     The usefulness of the research was increased by the clear writing requirements

and prompts for the reflections, specifically asking participants for their feelings or

environmental attitudes and making journal responses of connections to the course

content. Bias on the part of the researcher was reduced as categories for journal

reflection were preassigned, consisting of participants' attitudes, behavior, and course

content. Hatch (2001) stated in his review of the value for using journal data that, "The

most obvious strength of journals as data is that they can provide a direct path into the

insights of participants" (p. 141). Data were systematically processed via holistic and

categorical review. Additionally, cross-checking of findings compared participants'

journals and final anonymous reflections for validity and accuracy.

CHAPTER IV

RESULTS

The purpose of this study was to test and describe the impact of service-learning on environmental literacy in undergraduate students. Environmental literacy was indicated by students' affective attitudes and behaviors toward environmental issues and knowledge of environmental biology. This chapter presents results of data analysis from the Environmental Literacy Survey (ELS) of undergraduates at a small liberal arts university. Quantitative data included participant questionnaire ELS data that were entered into SPSS (version 19.0) for descriptive statistics, t tests, and repeated measures ANOVA significance testing. Qualitative data included students' personal reflections and group portfolios.

Findings

Thirty-seven students were enrolled in Environmental Biology, a biology course at a branch campus of a southern Christian university. One student dropped the course; therefore, the total number of participants completing this study was 36 (N=36). Twenty-four participants (66.7%) were enrolled in the course during the spring 2012 trimester; 12 participants (33.3%) were enrolled during the summer 2012 trimester. The same instructor taught the course in both trimesters. The frequencies and percentages of participants by gender, age, and academic major are presented in Table 2.

Table 2

Frequency and Percentage Statistics of Participants by Gender, Age, and Academic

Major (N=36)

Variable	*f*	%
Gender		
Male	2	5.6
Female	34	94.4
Age (years)		
18-23	6	16.7
24-29	10	27.8
30-39	11	30.6
40-49	7	19.4
50 and above	2	5.6
Academic major		
Biology	4	11.1
Business	1	2.8
Elementary Education	22	61.1
Nursing	3	8.3
Psychology	6	16.7

There were 34 female participants (94.4%) and 2 males (5.6%). The greatest

number of participants indicated they were elementary education majors (61.1%)

followed by psychology (16.7%), biology (11.1%), nursing (8.3%), and business (2.8%).

The age of participants reflected the nontraditional age composition of students at this

university branch (see Figure 9). The age range for this study was 18 years to over 50

years reflecting a broad distributed age range, more typical of nontraditional college

populations.
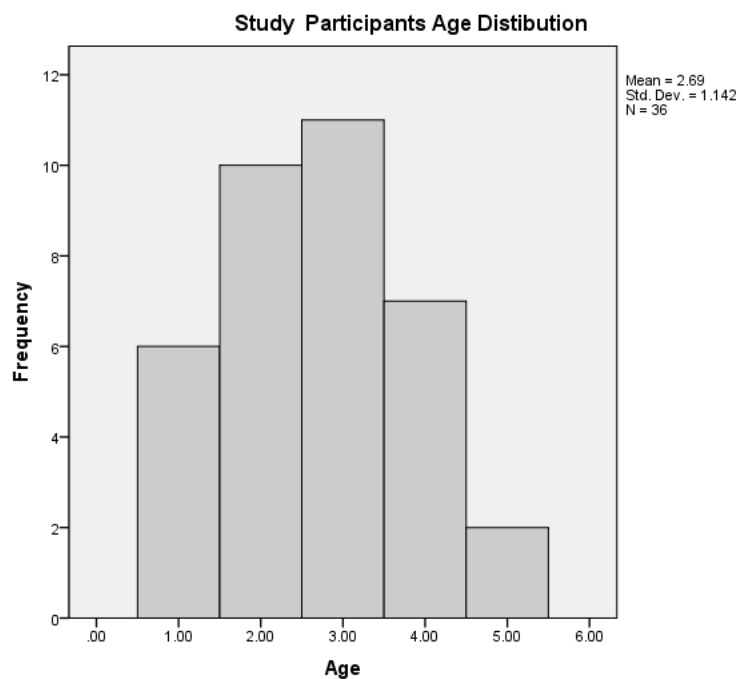
Figure 9. Participants' age distribution.

The largest population of participants in the study reported their age in the 30-39 category (30.6%) followed by the 24-29 category (27.8%). The categories of 40-49 (19.4%) and 50 and over (5.6%) combined to make approximately 24% of the participants. The 18-23 age category, which is more characteristic of the traditional college student, composed 16.7% of the total participants.

All participants completed the Environmental Literacy Survey at the beginning of the course and after the randomly selected groups completed service-learning (experimental) or the alternate activity (control). These data were utilized for the pretest and posttest comparisons. For purposes of the course requirements, the groups were alternated at the midpoint of the trimester which resulted in all groups completing a service-learning activity and the alternate activities. The ELS was completed a third time at the end of the course. The ELS questionnaire's three subscales measure an individual's

affective or attitude related to environmental issues(A), self-reported behavior as it relates

to the environment (B), and knowledge of environmental biology (C). Each subscale

consisted of 15 questions with ascending numeric values of 1 to 5, where 5 represented

the highest level of environmental literacy and 1 the lowest level of environmental

literacy. Each subscale total had a minimum possible score of zero and maximum score

of 60. The combined scores reflect a measure of environmental literacy as previously

defined. Missing values on the environmental literacy survey for sections A (Attitude)

and B (Behavior) were calculated by the mean of the remaining students' responses for

that specific section. Missing values for the Knowledge section (C) were given the

scoring value of zero, which is based on the customary scoring on multiple-choice

testing.

To establish equivalency of the groups between trimesters, scores on the pretest

were compared. Independent samples $t$test on the means of the groups were conducted.

The mean of the spring trimester group($M = 2.44$, $SD = 5.04$) was not significantly

different from for the summer group ($M = 2.34$, $SD = 5.14$) for the A subscale ($t[34] =$

$.05$, $p=.96$). The mean of the spring trimester group ($M = 4.45$, $SD =6.01$) was not

significantly different for the B subscale ($t[34] = -.195$, $p=.84$) than the mean of the

summer trimester group ($M=4.84$, $SD=4.57$) on the B subscale. The mean of the spring

trimester group ($M =.833$, $SD=7.07$) was not significantly different for the C subscale

($t[34] = -1.71$, $p=.09$) and the mean of the summer trimester group ($M = 5.66$, $SD=9.56$).

To determine any differences in control and experimental groups at the beginning

of this study, the Environmental Literacy Survey was administered and data were

analyzed utilizing a t test. The t test compared both experimental and control

groups'mean scores on the pretest to determine any significant differences between the

groups. The second administration of the questionnaire was used as the posttest scores for the experimental or service-learning group and the group that did not have service-learning (control) in the first part of the trimester. There were no reported statistically significant differences between the pretest mean scores for the groups on attitude (A subscale), ($t[34] =-.26$, $p=.79$); behavior (B subscale), ($t[34] =.97$, $p=.33$); or knowledge (C) sections, ($t(34)= -.638$, $p=.52$).

Summary of Pretest Scores

The Attitude (A) section of the Environmental Literacy Survey asked students to respond how they felt regarding statements related to their interest in, concern for, and ability to make contributions to environmental related issues. Participants' overall mean score on the pretest environmental attitude subscale (A) was 45.46. The behavior (B) subscale overall mean for students on the pretest was 22.45. The C subscale, which measured knowledge of environmental principles, provided a value of 32.66 for the overall mean on the pretest. The highest score for each subscale or subscale was 60, and the lowest was zero. These data are presented in Table 3.

Table 3

Pretest Means for all Participants (N = 36)

Subscale	*M*	*SD*	Medium	Maximum
Attitude	45.47	6.96	31.00	57.00
Behavior	22.46	9.60	3.00	40.00
Knowledge	32.67	10.36	12.00	52.00

The behavior subscale (B) is the lowest score on the Environmental Literacy Survey in this group of participants, with attitude the highest and knowledge in between in value. The literature reports other studies that reflect this pattern of subscale scores from a variety of populations and countries. Studies from the United States that reported this pattern included undergraduates in Florida (Kibert, 2000) and college faculty in Florida (Green, 1997). Scott and Willits (1994) reported that citizens in Pennsylvania were more likely to have a higher environmental attitude than behaviors reflecting environmental literacy. A study conducted with youth in Australia (Connell, Fien, Lee, Sykes, & Yencken, 1999) and Dutch youth (Kuhlemeier et al, 1999) found attitudes to be higher than behavior scores. Diekmann and Preisendorfer (1998) found that citizens of Germany and Switzerland reported discrepant scores between perceived attitudes and personally reported environmentally positive behaviors (see Tables 4 and 5).

Table 4

Means and Standard Deviations of Subscale Scores

Subscale	Pretest		Posttest	
	M	*SD*	*M*	*SD*
Attitude				
ESL Group	45.06	5.92	46.71	5.31
Control Group	45.66	7.94	46.66	5.65

Table 4 (continued).

Subscale		Pretest		Posttest	
	M	*SD*	*M*	*SD*	
Behavior					
ESL Group		24.00	8.62	28.61	7.33
Control		20.88	10.50	24.33	9.73
Knowledge					
ESL Group		31.56	11.13	35.33	12.36
Control		33.77	9.72	40.44	9.08

Note. ESL group (*n* =18) and control group (*n* = 18).

Table 5

Composite Score Environmental Literacy (ELS)

Group	Pretest	Posttest
Environmental Service-Learning	100.62	110.65
Control	100.31	111.43

Research Questions

This study investigated the impact of environmental service-learning projects on

students to determine if they performed significantly higher on an instrument designed to

measure environmental literacy (affective, behavior, and cognitive subscales) than

students who did not participate in an environmental service-learning project.

Statistical Analysis

Repeated measures one-way ANOVA statistical analysis was performed using the

pretest and posttest as the dependent variable comparing the experimental group scores

(service-learning group) and control group scores (alternate activity group).

*Hypothesis 1.*Students' *attitude* or affective scores will be statistically higher after

environmental service-learning. Questionnaire scores on the A subscale of the ELS

addressed students' attitudes related to environmental scores from students who had

completed service-learning (experimental) were statistically significantly higher than

students' scores who had not completed service-learning (control). One-way repeated

measures ANOVA results showed that the results of variances between levels were

significant.The results showed that $F(1,35) = 5.16$, $p=.029$.

*Hypothesis 2.*Students' *behavior* scores will be statistically higher after

environmental service-learning. The B subscale of the ELS measured participants'

responses to questions regarding environmentally positive behaviors. One-way repeated

measures ANOVA results showed that students scored higher on the behavior subscale

after completing service-learning (control) than the student group who had not completed

service-learning (control). Degrees of freedom were corrected using Huyn-Feldt

correction,$F(1,35) = 34.55$, $p =.000$.

Hypothesis3. Students' *knowledge* scores for environmental and ecological

content will be statistically higher after environmental service-learning. One-way

repeated measures univariate analysis of variance (ANOVA)results showed that students

who completed a service-learning project scored statistically higher on the knowledge

subscale than students without environmental service-learning using Huynh-Feldt

correction,$F(1,35) = 11.39$, $p = .002$.

Hypothesis 4. Students' *environmental literacy* scores will be statistically higher

after service-learning. The combined environmental scores were considered to be less

statistically usable as the Behavior subscale was initially lower in value resulting in

composite scores heavily weighted down from the B subscale. This trend has been noted

in the literature review. The researcher determined that it exerted an influence that

skewed the composite scores; therefore, each subscale was evaluated independently.

Qualitative Analysis of Environmental Service-learning Journals and Portfolios

Specific research question 1. What was the relationship of environmental service-

learning on attitudes regarding environmental issues in undergraduate students enrolled in

a biology course? Many positive statements in the students' journal reflections on

environmental service-learning were categorized as affective or Attitude. Common

attitude markers apparent in the journals included affective terms of pride, excitement,

and enjoyment. Melissa, a member of the butterfly garden project, after much group

planning, commented in her journal reflection regarding the preparation of the garden, "I

am really excited to get it all going on Monday."

Most participants' journal entries included personal statements related to positive

feelings or attitudes regarding their impact and awareness of environmental issues, such

as wildlife habitat loss, pollution, and consumption of resources. Journal entries

repeatedly echoed the perception that their service-learning project had a positive impact.

Jean wrote, "We can make a difference in how and what we use in our homes,

workplaces, social gatherings and other places." Another wrote, "What a sense of

accomplishment."

Gina and Sheila, members of the birdhouse project, stated, "I am really excited to get it all going on Monday." And "I felt proud that I could actually say I helped to build a habitat and give these birds a home." Sheila stated that "A project that we thought would be so hard turned out to be easy and fun." Lee's reflection related to the birdhouse project,

> I feel like this was a positive experience and I am glad that I could be a part of it. Our group found out today in class that a bluebird laid five eggs in one of our bluebird houses, and that made me feel like our group really accomplished one of our objectives.

> Debra, a member of the group that surveyed the biodiversity of the campus' adjacent wooded area, commented, "I have not had this much fun trotting through the woods since I was a child. Hearing the birds singing and the trees blowing in the wind was a beautiful experience for me." Lisa summarized in a final journal statement, "I really enjoyed this project. I am glad we were given the opportunity to make a difference."

An emerging theme related to attitude was the responses articulating a sense of pride in the projects that were produced by the service-learning groups. This positive attitude theme was also noted in the anonymous final student reflections. These final reflections did not include prompts for feelings or attitudes relative to the outcome or product of the service-learning projects. These common themes noted in both the students' journals and anonymous final reflections substantiate these findings (see Table 6).

Table 6

Student Service-Learning Reflections Related to Environmentally Positive Attitudes

Project	Reflections/ Comment Phrases Coded for Attitude
Wildlife habitat	"It was a great experience."
Butterfly garden	"I wish more people know how great it is to do something back for nature since it does so much for us."
Birdhouse	"I felt so proud."

The service-learning project generated an evolving attitude in some individuals. Sarah initially remarked in her journal entry, "I am not sure how this project is going to work out. I am not a huge fan of group projects." After the campus wildlife habitat began to take form, Sarah wrote, "Today we met to plan taking care of the habitat that we have created here on campus. Every day it looks better and better. I can't wait to bring my kids out here so they can see something positive that their mom has started on campus." In her final journal entry Sarah shared,

> I was able to bring my children out this Saturday to look at the project. They are 6 and 8. They loved it. My daughter loved the butterflies and birds. Seeing the project through their eyes made me realize that it is my job to educate them on how such a small piece of land means so much to the animals. When we got home my children found a spot in our backyard to start their own project. We have cleared the land to get started. I must say I am excited.

Many students included comments related to appreciation for the aesthetic value of the environment or an increased awareness of native animals and plants. These findings

are validated through statements made on the final anonymous reflections. One student

commented that service-learning had "made me appreciate my surrounding," and another

stated, "I will now view nature and its surroundings in a whole different light."

Environmental Behavior

   Specific research question 2. What was the relationship of environmental service-

learning on students' environmentally positive behaviors? Service-learning that utilized

student reflections and portfolios provided data relative to behaviors and skills learned.

Specific behaviors and skills acquired by the butterfly garden groups included designing

and physically preparing the ground for planting. The preparation included physically

breaking up the ground, adding soil, and removing grass. Students then placed plants in

the prepared garden and were responsible for watering and tending.

   Problem-solving and critical thinking are described processes that can occur in

quality service-learning. In this study, behaviors relative to environmental service-

learning that were not initially coded for but arose repeatedly within the reflections

involved these components. Students worked in groups of 4 to 6 individuals to

investigate possible projects followed by setting specific goals. Once goals were set

plans were developed and the groups found this to be more difficult than they expected.

Common problems involved getting group members to agree with plans and delegating

tasks within the group. Students described feeling frustrated and overwhelmed.

Collaborative group work is not limited to positive experiences as some students

expressed frustration with some members of the group participating less or that group

members did not share work responsibilities equally. The participants in this study were

more representative of nontraditional student populations; many students worked and had

families. Students made comments expressing frustration regarding scheduling conflicts

and personality conflicts. Some of this scheduling frustration was reduced as all service-learning projects were based on the campus. Group members were observed in the processes of collaboration, brainstorming, problem-solving, and written and oral communication among group members. Through writing in journals and oral presentations to the class, service-learning students engaged in quality practices of service-learning.

The butterfly garden service-learning group experienced additional opportunities for skill building. Within 5days of completing the butterfly garden, a large weather system caused considerable rainfall and the butterfly garden was severely impacted. The students were very discouraged initially that their planning and work were destroyed. The group began to brainstorm the problem of runoff and erosion relative to the placement of the garden. Courtney's reflective response to this dilemma was, "We discovered we were going to have a lot to do besides planting flowers. The original flowerbed needs to move due to water runoff during rainy weather." The group engaged in problem-solving by studying the slope of the surrounding ground and moved the garden to a less vulnerable location, which required significantly more group effort but resulted in less erosion to the butterfly garden.

Another of the service-learning groups researched building birdhouses and hanging hummingbird feeders. This group visited the local Audubon Society Center and consulted with the onsite wildlife naturalist gaining information on design and proper placement of the houses. The behaviors and skills gained included building the birdhouses to the specifications for different species requirements. The university allowed a maintenance employee to supervise the use of equipment in preparing the birdhouses and placing the owl houses at the proper tree height. Angela, a member of the

birdhouse project stated, "I learned how to build a birdhouse today using a staple gun and a drill" (see Figure 10).

Figure 10. Birdhouses on campus.

The campus recycling group contacted the local waste company regarding costs and requirements for institutional recycling. Following this research, the group made a presentation to the dean of the campus gaining his support for the project. They designed posters and decorated recycling cans. Deanna wrote that she was proud of what her

group had been able to accomplish and that next she, "will need to educate others about the benefits of recycling and how they too can make a difference in our environment" (see Table 7). The specific described activities of the service-learning groups are evidence that service-learning projects developed environmental skills and behaviors in participants.

Table 7

Student Service-Learning Environmental Behaviors and Skills

Project	Theme/Environmental Skills and Behaviors
Wildlife habitat	Constructed toad abodes.
	Butterfly garden preparation and planting
	Constructed bird feeders.
Birdhouse	Constructed owl and bluebird houses to species specifications.
	Talking to family and friends about positive environmental actions
Campus biodiversity	Tree and plant identification utilizing dichotomous keys
	Daytime photography, nighttime use of "critter cams"
	Natural history of native plants and animals
	Analyzing ecological density of trees
	Amphibian identification utilizing vocalizations
	Track and scat identification of native and nonnative species.

Table 7 (continued).

Project	Theme/Environmental Skills and Behaviors
Campus Recycling	Recycling
	Educating others
All Projects	Problem-solving, critical thinking, group process skills

Many of the above behaviors can be described as specific skill sets related to environmental issues. Problem-solving, critical thinking, and group process skills are applicable to most real-world or workplace settings.Bowen (2010) stated the importance of relevance of environmental service-learningto real-world application.

Knowledge of Environmental Content

Specific research question 3. What was the relationship of service-learning on conceptual learning and knowledge of scientific content relative to ecological and environmental education of students enrolled in undergraduate biology courses? Content knowledge and connection to the course content were emphasized by the instructor and in the journal writing directions.

Each participant in service-learning was instructed to include in their personal reflections the *C* component of the ABCs of reflection. The *C* component of reflection prompts the student to make connections relevant to the course content. Anne stated in her service-learning reflection that, "I felt like I understood what my teacher talked about in class." A member of the butterfly garden remarked in service-learning reflection, "This project relates a lot to our class. I realized everything plays off one another and if we

bring in certain elements for one species others would be able to live off it too." In response to the prompt for connections to the course content, Jordan stated in service-learning reflection, "Our goal is to enhance biodiversity by creating a habitat with host flowers for butterflies. From reading in Chapter V, this researcher learned that insects are important to the ecological system." This student continues later in their writing, "Our choice of a project connects to Chapter V on the aesthetic value of species in ecology." The reflection prompts to make connections to the course content increased the usage and application of ecological concepts and investigation of environmental problems throughout the journals, though not uniform as evidenced in Table8.

The service-learning group that designed the wildlife habitat researched criteria and specifications of a certified wildlife habitat through the National Wildlife Federation. In order to be certified by the NWF, four critical components in the wildlife habitat were required which included the following: (a) water source for local animal inhabitants, such as bird baths; (b) food sources for wildlife, such as native plants and dead log feeders; (c) cover for wildlife that offers protection; (d) brush shelters, native vegetation; and (e) nesting sites, places to raise young. These components relate to the basic biological needs of species. In the students' research for the project, they could connect to the ecological principles introduced in the lecture component. One student wrote, "We had to place the houses a good distance from each other to help decrease competition for a home, which we learned from our textbook and other research." Other specific content learned was reflected in a comment, "After researching birdhouses for the first time, I did learn that certain birds like certain houses and some actually have their own type of house."

Other specific comments relating to the content of the course included: "[Service learning project] gave me a greater understanding of the different types of relationships animals have together in the wild." Table 8provides examples of specific quotations from students' reflections. These phrases were not coded or translated by the researcher. Using reflections for qualitative studies allows for the researcher to directly exam the data that is in contrast to a researcher interviewing participants, interpreting, and coding participants' responses.

Table 8

Student Service-Learning Reflections Related to Environmental Biology Course Content

Project	Knowledge Theme
Wildlife habitat	"loss of habitat, human impact"
	"diversity of species"
	"pollution"
	"cycles of nitrogen, phosphorus, sulfur, hydrologic"
	"endangered species"
	"Toad abodes can be constructed to provide shelter for amphibians on land."
Birdhouse	"definition of habitat"
	"competition for food and nesting sites"
	"native versus nonnative species"

Figure 8 (continued).

Project	Knowledge Theme
Butterfly garden	"invasive species"
	"even the smallest species has a big role in the ecosystem"
	"energy exchange in ecosystems, photosynthesis, respiration
	"trophic levels, producers, consumers"
	"nitrogen cycles"
Campus biodiversity	"niche" concept
	"Food web"
Campus recycling	"Human consumption and waste production" "Pollution"

An the end of the course, final anonymous reflection on service-learning included the following questions or prompts:

1. Are there concepts/topics you learned from the service-learning experience that you would not have learned in the classroom?

2. Are there concepts you learned in class that you understand better because of service-learning?

3. How would you describe your overall experience with service-learning?

The first two questions were answered by *yes* or *no*; however, some participants provided additional descriptions in their writings. All of the students answered *yes* to the first question regarding concepts that were learned in service-learning. All of the

students answered *yes* to the second question except for one student responding *no* to the question of greater understanding concepts due to service-learning. The third question required a more descriptive response from the students. Two themes emerged that were also present in many journals. The first noted by the researcher was the initial reaction of students to the amount of work involving the environmental service-learning projects. Statements such as "overwhelmed" initially but at the end of the project students reported that the "learning value greatly outweighed the difficulties of the project." A number of students anonymously stated that they wished they had more time to devote to the service-learning project. A second emerging theme was the difficulty of group work.

Environmental Literacy

Some students reflected on the larger context of environmental issues that were inclusive of attitudes, behavior, and content, such as "Today I learned that I care more about making a change than ever before." A member of the campus biodiversity project made the comment that, " I realized after doing this project, that the goal was not only to inform us of what types of plants and animals are inhabiting our campus, but also for us to appreciate fully how much biodiversity is right in our own 'backyard'."These comments in the student reflections are indicative of environmental literacy development. Environmental literacy,as previously defined, encompasses affective components, specific behavioral skills, and content knowledge relative to ecological content. Evaluating the reflections, portfolios, and quantitative data holistically is supportive evidence that environmental service-learning increases the growth of environmental literacy in participants.

Summary

The purpose of this study was to investigate the role or impact of service-learning experiences on undergraduate students' environmental attitudes, behaviors, knowledge, and overall environmental literacy. The National Youth Leadership Council (NYLC) in 2008 identified a set of research-based standards for service-learning in K-12 practice that can be extrapolated to undergraduate service-learning. These standards were used as a guide in developing the service-learning activity for this study. These standards include reflection activities, as an instructional strategy to meet learning goals, collaborative and mutually beneficial to partners, planning and implementing with guidance, and of sufficient duration and intensity (NYLC, 2008). As previously described, research-based standards for service-learning were used for the design and implementation of this study's service-learning. Journal reflections were a key piece of this standard following the ABCs that also parallel the instrument used in this study (Boise State University Service-Learning, 2012). In reflection, the letter *A* of ABCs represents the journal writing in which the student addresses his or her attitudes or affective perspective of the project. The *B* of ABCs of journal reflection represents the behaviors or skills that are acquired. The final letter*C* of the ABCs prompts the student to write on the specific connections or knowledge learned relating to the course content for which the service-learning is an activity. The ABCs of reflection align with the subscales of the Environmental Literacy Survey instrument utilized in the study. The *A* subscale of the instrument was developed to assess the respondents' attitudes specifically related to environmental literacy. Respondents were prompted to indicate how they felt about statements related to aesthetic appreciation for the environment, concern for environmental issues, and environmental legal policy. For example, respondents chose

from*Strongly agree =*1, *Agree =*2, *No opinion = * 3, *Disagree = * 4, or *Strongly disagree = * 5 relative to a statement, such as "More land should be set aside for wildlife habitats."

On the *B* subscale of the ESL, respondents were asked to indicate the frequency of actions involving activities, such as recycling, talking to friends or family regarding actions to help solve environmental problems, reading about environmental issues, or engaging in citizen advocacy. This subscale aligns to the *B* of the reflection's ABCs, prompting students to write about behaviors or skills acquired. Lastly, the *C*s of both the reflection prompts and the *C* subscales of the questionnaire relate to the knowledge acquired or content connections to the course. The *C* subscale is a multiple-choice section relating to specific knowledge of environmental biology. Some of the content includes questions on the subject of ecological principles, such as food webs, habitat, photosynthesis, biodiversity, bioaccumulation, pollution, and endangered species.

Research questions and hypotheses were developed to address the attitude, behavior, and knowledge aspects of environmental literacy of service-learning participants. Hypothesis testing and research questions were evaluated based on answers to the three subscales of the Environmental Literacy Survey, service-learning portfolios, and personal journal reflections of service-learning participants. An impact of this study is the utilization of quantitative and qualitative data relative to environmental service-learning. MacFall (2012), a researcher of environmental service-learning at the college level, reported long-term positive outcomes. MacFall (2012) stated that there is a need for quantitative studies as there is less quantitative analysis than qualitative at the college level.

A repeated measures design using the Environmental Literacy Survey instrument was utilized to gather quantitative data. The ELS instrument was administered three

times, initially as a pretest for all participants, a second time upon completion of the first

group's service-learning project, and a third time at the completion of the second group's

service-learning project. The second test served as the posttest for the first service-

learning group and the alternate activity group (control). A univariate repeated measures

ANOVA was performed for each of the ESL subscales: attitude, behavior, and

knowledge. The reversal of activities in the second half of the course allowed for all

students to participate in service-learning projects and alternate activities. This design

reduced the incidence of resentful demoralization whereby all students were given the

opportunity to participate in all activities of the course. The study design had the

advantage of one instructor which reduced differential instruction and differential

service-learning quality which was addressed by England and Marcinkowski (2007) as a

challenge to assessing the impact from environmental service-learning.

There were 36 students enrolled in two trimesters who completed all course

requirements for Environmental Biology, an undergraduate course at a small private

liberal arts university (*N*=36). Thirty-four of the participants were female and 2 were

male. The nontraditional population of the campus is reflected in the age distribution. Six

students were in the 18- to 23-year-old category, 10 students were in the 24- to 29-year-

old category, 11 were 30- to 39-year-old in age, 7 students reported to be between 40 and

49 years, and 2 students were 50 years or older. The population of the courses was

dominated by 22 elementary education majors. The remaining majors represented in the

participants included 6 psychology majors, 4 biology majors, 3 nursing, and one business

major. The equivalency of the trimester participants was established with independent

samples ttest on the mean gain pretest scores for all participants.

To establish equivalency between service-learning groups and alternate activity groups at the outset, *t* tests were performed comparing the pretest scores of the groups for each section on the Environmental Literacy Survey. The researcher looked at using the mid-trimester scores of the ELS as the pretest for the control group (alternate activity group) instead of using the first instrument results as the pretest for all participants, which was prior to any classroom instruction or treatments. Analysis revealed no statistical difference between the two groups in their subscale scores or overall environmental literacy. A univariate repeated measures ANOVA was performed for each of the ESL subscales: attitude, behavior, and knowledge to examine the hypotheses.

CHAPTER V

DISCUSSION

This chapter will summarize this study, present a discussion of the results, and suggest future research for environmental literacy studies in undergraduates at university settings. Conclusions and limitations of this study will be described.

Research Findings

This study evaluated the impact or effect of environmental service-learning on environmental literacy in undergraduates. Data were collected on attitude, behavior, and knowledge aspects of environmental literacy as measured by qualitative journal reflections and the Environmental Literacy Survey.Descriptives and frequencies of the participants and variables were analyzed. Hypotheses were tested by independent sample *t*tests and repeated measures ANOVA. The *t* test analysis of pretest survey scores for all three subscales revealed that the environmental service-learning groups and control groups did not differ significantly on the pretest. Thus, participants can be assumed to be equivalent groups at the initiation of the study. Repeated measures ANOVA conducted on participants' three subscales scores for the ELS (attitude, behavior, and knowledge) indicated that students who participated in environmental service-learning scored statistically significantly higher than those that did not initially participate in service-learning.

Qualitative data collected included student service-learning journals, portfolios, and anonymous final reflections. Evaluation of the data included deductive coding for themes of environmental attitudes, behaviors, and ecological content. Emerging themes that were noted included problem-solving and group process skills.

Attitude Regarding Environmental Issues

Students who took part in environmental service-learning scored statistically higher than students that had not completed a service-learning project on the attitude section of the ESL. The mean of all pretest scores for the attitude subscale was the highest initially of all three subscales, *M*= 45.57. These scores are similar to those reported in 817 undergraduates at a large university in Florida. Utilizing the same instrument, Kibert (2000) reported a mean of 42.3 on the attitude section of the ELS. The attitude section was also the highest score of the three subscales in that population.

In this study the posttest for the environmental service-learning group rose to 46.31 and alternate activity group to 46.66. Scores on attitude did not rise appreciatively which may reflect more pro-environmental attitudes in the population initially.

 Several comments in journaling made reference to the positive experience of making a final service-learning project presentation to the whole class and to the dean of the campus. They wrote ofpride, teamwork, excitement, and accomplishment. As Aronson et al. (2005) suggested learning is influenced by feelings and values that were supported in this study by the quantitative data from the Environmental Literacy Survey and the qualitative analysis of journal reflections. Students were enthusiastic and engaged with the content material this researcher suggested due to the hands-on environmental service-learning projects.

Environmental Behavior Related to Environmental Issues

Students who took part in environmental service-learning scored statistically higher on the behavior section of the ESL than students who had not completed a service-learning project.The mean of behavior subscale was 22.46, a score that was initially the lowest of all the pretest scores for all groups. Kibert (2000) reported a mean for this

section in the University of Florida undergraduates of 23.4. This finding is similar to other reported studies (Connell et al., 1999; Diekmann&Preisendorfer, 1998; Kuhlemeier et al., 1999; Scott &Willits, 1994).

Service-learning may also in the larger context give participants specific skills and behaviors that yield a tangible product or outcome via the project completion. These behaviors and skills could increase the likelihood that individuals may feel empowered in the future to volunteer and participate as environmental stewards. Sean stated in a final service-learning reflection, "I did not realize our group would have made that much of an impact." Anne wrote, "Through this project I have learned that we can all do small things to make a big difference in our futures and the futures of our children." These statements support an increase of self-efficacy in students participating in service-learning. Moore (2003) promoted service-learning as a means to enhance self-efficacy; self-efficacy can be described as a component of environmental literacy. A number of students identified with the quote from Margaret Mead, "Never doubt that a small group of thoughtful, committed, citizens can change the world. In fact, it is the only thing that has."

This study utilized active learning activities alternating with the environmental service-learning projects. Service-learning supporters suggested studies that compare active learning methods to service-learning (Battistoni, 2006). Active learning is an accepted method for enhancing learning and engagement with content material. This study suggests that the major advantages to utilizing service-learning as pedagogy are the students' experiences with specific behaviors. By analyzing the reflections written by each student, it is evident that these behaviors include pro-environmental skills but

additionally provide problem-solving, critical thinking and, importantly, the group

process skills. Other active learning methods may not provide these experiences.

Knowledge of Environmental Concepts

Students who completed an environmental service-learning project scored

statistically higher on the knowledge section of the ESL than students who had not yet

completed a service-learning project. Knowledge was the middle mean scoring subscale

in this study ($M = 32.67$) as was the University of Florida study ($M= 39.3$)(Kibert, 2000).

All mean scores increased on all subscales of the Environmental Service-Learning

Instrument whether the groups were in the service-learning activity or the alternate

activity. The alternate activity was designed by the researcher to purposely lack

important elements of quality service-learning, such as group problem-solving, group

interactions, and most specifically journal reflections. The alternate activities included a

self-guided scavenger hunt of the Sandhill Crane Refuge in Van Cleave, Mississippi, and

a PowerPoint presentation on an endangered species. These activities were designed to

increase the knowledge of environmental and ecological content which may have

contributed to the rise in knowledge section scores.

The increase in knowledge is a valued goal for environmental literacy and a

course in environmental biology. However, a quality service-learning activity has the

advantage of increasing knowledge but additionally can develop collaborative group

work, problem-solving, critical-thinking skills, and attitudes that are reflected in many of

the journal statements.

A common topic expressed in students' journaling addressed the positive aspect

ofhands-onlearning in service-learning. Students expressed that hands-on learning

assisted in learning lecture content. Regina stated that, "I truly enjoyed working on this

service-learning project. I believe the best way to learn things is by hands-on activities and the ability to make real-life connections to content taught in the classroom." Another student stated, "I understood the concepts more because of service learning." The majority of students in this study identified elementary education as their academic major. Paul wrote, "I will use servicelearning as a future teacher." Service-learning experiences may have a significant impact for pre-service teachers by modeling service-learning and hands-on activities. As Bowen (2010) stated, faculty report the opinion that service-learning provides practice of course content and increases understanding.

As Bradley (2003) described, service-learning experiences can involve many of the components ofGardner's Multiple Intelligences addressing the different ways in which people learn. The written reflections gave added strength to the analysis of the data. The students' words speak for themselves in many cases without the need of transcribing or translating. This study suggests that service-learning was as effective as a methodology that links course content to real-world application (Bowen, 2010).

Service-Learning and Environmental Literacy

The results of this study support the advocacy of place-based or campus-based projects (Coyle, 2005; Newman, 2008; Sobel, 2004). The service-learning projects were a course requirement and were not optional or simply volunteering. The planning, development, and implementation were time-consuming for participants and the instructor. Many of the students were categorized as non-traditional, and there were no resident students on campus. Campus-based projects provided fewer scheduling conflicts than projects located at a secondary site. Furthermore, the success of this particular study and its projects were due in part to the partnership of university administration, staff, faculty, and students.

Environmental service-learning is a powerful pedagogy as evidenced by one student's comments,

Today I felt accomplished by the amount of work that my team has been able to resolve on their own and together. I am proud of how hard my team has worked. Today I acquired the knowledge of my own personal footprint on the world.

A service-learning experience can increase the possibility that a student can make connections with course knowledge and provide an opportunity for education that is interesting and empowering and generates modeling for citizenship. In a study of the relationship between classroom instruction and service-learning, Markus et al. (1993) noted a synergism of the two to achieve learning. Belinda wrote in her journal that she had built and hung a bluebird house at her home following her service-learning project at the university. She had this to share in her final journal entry,

From this project I have learned that everything we, as humans, do impacts the environment and wildlife. Something as simple as driving a car causes pollution. Fertilizing a garden that was created to benefit wildlife can ultimately harm them. If we are careful with the tracks we leave behind, we can leave our future generations with something they can be proud of, but it has to start now and it has to be a serious effort. One more thing, I already have a bluebird nest in my birdhouse!!!!"

In a recent lecture at the University of Southern Mississippi., J. Baird Callicott, a leading environmental ethicist, spoke on the topic of Aldo Leopold's land ethic entitled From Land Ethic to Earth Ethic (2013). Leopold's classic book educates readers about ecology and the loss of environment. Leopold was one of the first conservationists providing a framework for environmental ethics. Told as a narrative and entertaining, it

is a subtle lesson in the necessity to preserve native lands and to allow damaged lands to return to their native states. Dr. Callicott proposed the need for governmental cooperation on a global scale and that democratic civilization may be imperiled. Dr. Callicott suggested that even though he personally practiced environmentally positive behaviors, that, in his opinion, all the personal environmental efforts are 'futile' to impact the global environmental problems. He contended the only way to have a significant impact was by voting for pro-environmental policies and laws. The results of this study would suggest that education on environmental literacy could be a precursor to positive environmental citizenship. Individuals could be more likely to vote for policy and laws if they are undergirded with scientific knowledge, positive attitudes, and skills related to environmental literacy. It is evermore imperative for citizens to have scientific and environmental literacy, especially regarding discussions on global climate change that are in some cases politically slanted.

Conclusions

All citizens, not just the scientific community, must make informed decisions regarding laws and policy related to environmental problems. John Dewey's philosophy of education, which proposes that schools should model life and prepare informed citizens for democratic involvement, is still relevant to today's educational pedagogy (1933, 1954).Higher education has a trinity of core functions including education and research with a resurgence of service as a goal (Harkavy & Hartley, 2010). Service-learning meets higher education's third core function for service that promotes the values of democracy (Thompson et al., 2011).

Service-learning may enhance knowledge, attitude, and experience with hands-on environmental strategies that are more effective specifically with regard to behaviors than

traditional learning strategies.Traditional educational methods may be as effective to impacting knowledge and affecting attitudes related to environmental literacy;however, students with knowledge of environmental strategies and specific practice with these strategies may increase environmentally responsible behaviors more so than those individuals with only knowledge and pro-environmental attitudes.This study provides meaningful support for service-learning and its capacity to prepare individuals for the 21st century workforce (Bybee, 2010).

Service-learning experiences that are well-designed could impact an individual's likelihood to engage in personal action by modeling group collaboration, problem-solving, and citizenship practice, all of which are practiced in a strong democratic civilization. Instructors are familiar with active learning exercises, such as this study's alternated activities, but what may distinguish environmental service-learning is the capacity to promote problem-solving and modeling positive environmental behaviors which may have a greater impact on environmental literacy.

The North American Association for Environmental Educators listed 17 competencies, knowledge, and dispositions for assessing environmental literacy (2011). It can be argued that of the 17 points in the framework, environmental service-learning provides 16 of the components, including identification, investigation, and evaluation of environmental issues. Knowledge of environmental issues and sensitivity or attitudes relative to environmental issues were equally developed in students in this study.The quantitative and qualitative results of this study suggest that environmental service-learning is a useful heuristic pedagogy in environmental literacy education.

Limitations

This study explored the relationship of service-learning to environmental literacy in 36 undergraduates enrolled in an environmental biology course at a small liberal arts university. These findings cannot be extended to the general population. One limitation of the study was the repeated use of the instrument. This limitation may be offset by the support of the qualitative data.

The sample size of this study could represent a possible limitation; however, a mixed methods approach could enrich the study's findings. Students may not have been completely honest or participants may not have given careful consideration to their answers on the questionnaire. Another limitation on the reflections could include students writing comments that they believed the instructor wanted to read or hear. The instructor was also the researcher which is a potential limitation, but this element also reduced the variability lecture topics and quality of service-learning experiences that could have occurred with multiple instructors.

<div align="center">Future Research</div>

The results of this study suggested lines of future research that could add to the body of knowledge related to environmental service-learning. A continuation of this study with a larger sample size could be more generalizable. A concurrent mixed methods study is suggested with a quantitative longitudinal study of postgraduates, as called for by MacFall (2012), and a qualitative component examining the long-term relationship of service-learning to knowledge, attitudes, and skills as they relate to environmental literacy.A potentially valuable study is a longitudinal study that investigates the impact or relationship of environmental service-learning on environmental literacy in teachers of elementary students.

Exploring the behavioral component of environmental literacy as it compares to positive environmental attitudes and knowledge, as previously reported, is an area of needed additional research. Investigating the specific element of self-efficacy, as a possible outcome of environmental service-learning and its impact on environmental literacy could be analyzed.

To address the theme of democratic or civic engagement, a longitudinal study tracking participants to determine increased involvement in voting, civic engagement, or their level of involvement in pro-environmental efforts as an outcome of environmental service-learning could have merit. Additional studies verifying and establishing relationships of democratic and civic engagement to service-learning have significant importance for higher education and society.

APPENDIX A

ENVIRONMENTAL LITERACY SURVEY

ENVIRONMENTAL LITERACY SURVEY ANSWER SHEET

Code Name_____

Date_____

Demographics. Please provide the following information. Your responses are completely

confidential. The demographic information is for analysis purposes only.

Gender.   Male_____   Female_____

Age Range.   18-23____   24-29____   30-39____   40-49____   50 and above____

List your major field of study. You may list more than one.

_____

_____

List any minor field of study.

_____

Instructions for Section A: Please indicate how you feel about each statement below.
There are no right or wrong answers. Read each statement carefully. Circle the
number in the space on your answer sheet for the number that best indicates the extent
to which you agree or disagree with each statement, using the following key:

Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
(1)	(2)	(3)	(4)	(5)

A1.	(1)	(2)	(3)	(4)	(5)
A2.	(1)	(2)	(3)	(4)	(5)
A3.	(1)	(2)	(3)	(4)	(5)
A4.	(1)	(2)	(3)	(4)	(5)
A5.	(1)	(2)	(3)	(4)	(5)
A6.	(1)	(2)	(3)	(4)	(5)
A7.	(1)	(2)	(3)	(4)	(5)

A8.	(1)	(2)	(3)	(4)	(5)
A9.	(1)	(2)	(3)	(4)	(5)
A10.	(1)	(2)	(3)	(4)	(5)
A11.	(1)	(2)	(3)	(4)	(5)
A12.	(1)	(2)	(3)	(4)	(5)
A13.	(1)	(2)	(3)	(4)	(5)
A14.	(1)	(2)	(3)	(4)	(5)
A15.	(1)	(2)	(3)	(4)	(5)

Instructions for Section B: For the following group of statements, please indicate how frequently you do each of the actions mentioned. Be honest, there are no right or wrong answers. Circle the number on your answer sheet for the number that is closest to your answer, using the following key:

Almost always	Often	Sometimes	Almost never	Never
(1)	(2)	(3)	(4)	(5)

B1.	(1)	(2)	(3)	(4)	(5)
B2.	(1)	(2)	(3)	(4)	(5)
B3.	(1)	(2)	(3)	(4)	(5)
B4.	(1)	(2)	(3)	(4)	(5)
B5.	(1)	(2)	(3)	(4)	(5)
B6.	(1)	(2)	(3)	(4)	(5)
B7.	(1)	(2)	(3)	(4)	(5)
B8.	(1)	(2)	(3)	(4)	(5)
B9.	(1)	(2)	(3)	(4)	(5)
B10.	(1)	(2)	(3)	(4)	(5)
B11.	(1)	(2)	(3)	(4)	(5)
B12.	(1)	(2)	(3)	(4)	(5)
B13.	(1)	(2)	(3)	(4)	(5)
B14.	(1)	(2)	(3)	(4)	(5)
B15.	(1)	(2)	(3)	(4)	(5)

Instructions for Section C: For each of the following questions, choose the best answer. Circle the number corresponding to your answer on the answer sheet.

C1.	(1)	(2)	(3)	(4)
C2.	(1)	(2)	(3)	(4)
C3.	(1)	(2)	(3)	(4)
C4.	(1)	(2)	(3)	(4)
C5.	(1)	(2)	(3)	(4)
C6.	(1)	(2)	(3)	(4)
C7.	(1)	(2)	(3)	(4)
C8.	(1)	(2)	(3)	(4)
C9.	(1)	(2)	(3)	(4)
C10.	(1)	(2)	(3)	(4)
C11.	(1)	(2)	(3)	(4)
C12.	(1)	(2)	(3)	(4)
C13.	(1)	(2)	(3)	(4)
C14.	(1)	(2)	(3)	(4)
C15.	(1)	(2)	(3)	(4)

Environmental Literacy Survey

Instructions for Section A: Please indicate how you feel about each statement below. There are no right or wrong answers. Read each statement carefully. Circle the number in the space on your answer sheet for the number that best indicates the extent to which you agree or disagree with each statement, using the following key:

Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
(1)	(2)	(3)	(4)	(5)

A1 When I am outside, I usually don't notice the natural things around me like flowers, birds, trees, and clouds.

A2 I'm not interested in reading about nature or the environment.

A3 I think most of the concern about environmental problems has been exaggerated.

A4 A community's pollution regulations should not interfere with industrial growth and development.

A5 More controls should be placed on industry and agriculture to protect the quality of the environment, even if it means that things I purchase will cost more.

A6 I am not concerned about the fact that the world's deserts are increasing in size.

A7 There are already enough laws to protect the environment.

A8 I don't think that recycling is worth all the trouble it takes.

A9 More land should be set aside for wildlife habitats.

A10 I am concerned about how much waste is produced in this country.

A11 Laws should be passed and enforced that protect the quality of life in the future even if it means that individual freedoms are limited.

A12 I am not concerned about the rate of species extinction in the world.

A13 I am concerned about environmental health hazards such as those caused by air or water pollution.

A14 I believe that I can contribute to the solution of environmental issues by my actions.

A15 It's too hard to change my friends or family members' minds about doing things to help the environment (for example: recycling.)

Instructions for Section B: For the following group of statements, please indicate how frequently you do each of the actions mentioned. Be honest, there are no right or wrong answers. Select the number that is closest to your answer, using the following key:

Almost Always	Often	Sometimes	Almost Never	Never
(1)	(2)	(3)	(4)	(5)

B1 I turn off lights and appliances when they are not being used to conserve electricity.

B2 I talk to people that I notice doing something that harms the environment in an effort to persuade that person to stop the activity. (For example, try to convince a friend or family member to recycle a soda can instead of throwing it in the trash.)

B3 I walk, take public transportation, or ride a bike instead of using a car in order to help protect the environment.

B4 I make an effort to reduce the amount of goods I consume or purchase.

B5 I set a positive environmental example for my friends and family to follow.

B6 I support candidates for political offices who are concerned about environmental problems and issues.

B7 If I see an aluminum can on the ground when I'm out walking, I pick it up and take it with me.

B8 I recycle paper, glass and/or metal waste products at home or at school.

B9 I avoid purchasing products that have a negative impact on the environment.

B10 I talk to my family and friends about what they can do to help solve environmental problems.

B11 I write or call politicians to express my views about environmental issues.

B12 I make a point of reading newspaper and magazine articles about the environment.

B13 I purchase one product over another product because it is packaged in reusable, returnable or recyclable containers or packages.

B14 I send letters to the newspaper about environmental problems or issues.

B15 I have reported environmental problems or violations that I have noticed to the proper authorities.

Instructions for Section C: For each of the following questions, choose the best answer.

C1 A food web consists of

1) the animals that eat other animals in a community.

2) all the herbivores and carnivores in an ecosystem.

3) many interconnected food chains.

4) all the consumers in an ecosystem.

C2 All of the same individual organisms that live on the ground in a particular forest share the same

1) niche.

2) habitat.

3) life-style.

4) food source.

C3 Wolves eat deer. Does this interaction have any beneficial effects on the deer population as a whole?

1) Yes, the wolves help keep the deer population size controlled.

2) No. The deer population is only harmed.

3) Yes, the wolves help keep the population strong since the fastest, most alert deer survive.

4) both (1) and (3).

C4 Based upon major ecological principles, we should conclude that

1) humans are a climax species that will last indefinitely.

2) the human species will soon become extinct; nothing we can do will prevent this.

3) the human species will last as long as there is a balanced eco-system that will support human life.

4) there is no way of predicting what will happen to the human species; ecological principles do not apply to humans.

C5 The process of photosynthesis in green plants

    1) uses sunlight to burn energy in plants.

    2) changes light energy into chemical energy.

    3) changes chlorophyll into sugar.

    4) 4) is a process used to burn sugar stored in plants so the plants can grow.

C6 Which of the following terms is used to describe all of the natural living and non-living interacting features of a given area?

    1) habitat

    2) community

    3) biodiversity

    4) ecosystem

C7 A particular aquatic ecosystem is contaminated by a chemical which tends to remain stored in body fat. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem?

    1) plant life

    2) minnows

    3) fish that eat insects and plants

    4) fish-eating birds

C8 Which of the following phrases refers to the potential ability of a system to support population growth without harming the environment?

    1) carrying capacity

    2) species loading

    3) non-sustainable growth

    4) all of the above

C9 Some insecticides that were once effective in killing insects no longer work very well. This is because

    1) new insect species develop every day.

    2) the wrong kind of insecticides were used.

    3) insects with natural resistance survived and multiplied.

    4) the insects produced many more offspring than the insecticide could kill.

C10 Which of the following contributes to air pollution at the surface of the earth, and acts as a shield against ultraviolet rays in upper atmosphere?

    1) nitrous oxide

    2) methane

    3) ozone

    4) sulfur dioxide

C11 The main source(s) of emissions that have been identified as contributing to acid deposition (acid rain) in the United States are

    1) volcanoes and forest fires

    2) petroleum refineries

    3) automobiles and coal burning power plants

    4) aerosol sprays and refrigerant leakage

C12 The rate of species' extinction is higher now than at any time since the period of the dinosaurs' extinction. The main cause of this rapid decline in biodiversity is

    1) habitat alteration by humans

    2) the illegal poaching or collecting of animals and plants.

    3) changes in the Earth's atmosphere due to human activities.

    4) hunting by humans for food or sport.

C13 A major nuclear accident occurred in 1986 at the _____ nuclear power plant.

    1) Belgrade

    2) Nagasaki

    3) Chernobyl

    4) Three Mile Island

C14 Which of the following is most likely to help endangered species?

    1) Outlaw the sale or possession of endangered species or products made from them (skins, furs, ivory, etc.)

    2) Create breeding programs in zoos for endangered animals.

    3) Use farming methods which do not damage habitat.

    4) Maintain large protected natural areas where they live.

C15 In the long term, which of the following would be the best way to lessen the problem of solid waste?

     1) Incinerate waste materials

     2) Reduce the amount of materials being consumed.

     3) Reuse materials for other purposes rather than throwing them out.

     4) Recycle materials that can be used again.

This is the end of the survey.

Thank you for your participation!

APPENDIX B

PERMISSION TO USE ENVIRONMENTAL LITERACY SURVEY

Hello. The survey I used for my thesis was on a 5-point scale for the affective and behavioral sections and on a 4-point scale for the knowledge section. So there hasn't been any change to the scaling of the sections. You are authorized to use the survey which is attached to my thesis as an appendix for your dissertation with attribution back to the original survey. Thanks.

Nicole C. Kibert
Attorney at Law

4221 W. Boy Scout Blvd., Ste. 1000
Tampa, Florida 33607-5780
Direct: 813.229.4205 | Fax: 813.229.4133

APPENDIX C

APPROVAL OF THE UNIVERSITY SOUTHERN MISSISSIPPI

INSTITUTIONAL REVIEW BOARD

THE UNIVERSITY OF
SOUTHERN MISSISSIPPI.

INSTITUTIONAL REVIEW BOARD
118 College Drive #5147 | Hattiesburg, MS 39406-0001
Phone: 601.266.6820 | Fax: 601.266.4377 | www.usm.edu/irb

NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Institutional Review Board in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.
  Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **12011801**
PROJECT TITLE: **The Role or Impact of Environmental Service Learning on College Students' Environmental Knowledge, Attitudes and Behaviors**
PROJECT TYPE: **New Project**
RESEARCHER/S: **Joanna Lynn Singletary**
COLLEGE/DIVISION: **College of Science & Technology**
DEPARTMENT: **Center for Science & Math Education**
FUNDING AGENCY: **N/A**
IRB COMMITTEE ACTION: **Expedited Review Approval**
PERIOD OF PROJECT APPROVAL: **01/26/2012 to 01/25/2013**

Lawrence A. Hosman, Ph.D.
Institutional Review Board Chair

APPENDIX D

ORAL PRESENTATION

February 22, 2012

Dear Participant,

The purpose of this research is to gather information on the role or impact of environmental service-learning oncollege students' environmental attitudes, behaviors, and knowledge. This survey is not a part of your curriculum of this class and participation will not affect your grade. The survey should take less than 30 minutes to complete. You must be at least 18 years old to participate in this study and participation is completely voluntary. You may withdraw from the study at any time without consequence to you. Your confidentiality will be strictly protected. Your name will be replaced with a code. Only an independent source will have access to the master list that matches your name with the code. Participation should not require any extra time outside of class. All associated files will be securely stored in a locked file cabinet or password protected file. NO results will be reported in a manner that would allow a reader to associate any responses to you. You will not be purposely deceived, and this project does not pose physical danger. Participating in the study will subject you to no risks greater than those you normally encounter in everyday life.

This study is being conducted to provide a better understanding of how students' environmental literacy is impacted by participation in service-learning projects. Results from this study are for instructor informational purposes. Please feel free to ask any questions during or after your participation in this study. If you have questions or concerns about this study, you may contact me at 228-702-1880 or lynn.singletary@wmcarey.edu.

This project and this consent form have been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

Your signature on the attached consent form indicates that you have received a copy, read, and understand this letter that describes the study. The informed written consent is required by IRB for your participation.

Thank you for your consideration and help with this project.

Sincerely,

Lynn Singletary

APPENDIX E

INFORMED CONSENT FORM

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT

Participant's Name _____

Consent is hereby given to participate in the research project entitled The Role or Impact of Environmental Service Learning on College Students' Environmental Knowledge, Attitudes, and Behaviors. All procedures and/or investigations to be followed and their purpose, including any experimental procedures, were explained by Lynn Singletary. Information was given about all benefits, risks, inconveniences, or discomforts that might be expected. The opportunity to ask questions regarding the research and procedures was given. Participation in the project is completely voluntary, and participants may withdraw at any time without penalty, prejudice, or loss of benefits. All personal information is strictly confidential, and no names will be disclosed. Any new information that develops during the project will be provided if that information may affect the willingness to continue participation in the project.

Questions concerning the research, at any time during or after the project, should be directed to Lynn Singletary at 228-702-1880 or lynn.singletary@wmcarey.edu. This project and this consent form have been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to the Chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

A copy of this form will be given to the participant.

_____   _____
Signature of participant   Date

_____   _____
Signature of person explaining the study   Date

APPENDIX F

ABBREVIATED COURSE SYLLABUS

Course: Environmental Biology
Course Credit: 4 semester hours credit, 3 hours lecture and 1 hour laboratory
        Prerequisites: none
        Course Description: An introduction to the basic principles of environmental biology, ecology and the relationship between humans and the natural world. Topics covered will include, but are not limited to: ecology, biodiversity, habitat loss, pollution, human population concerns, climate change and deforestation. A one hour laboratory/ field component is included. Students with minimal science background may take this course. This course satisfies all core curricula laboratory requirements.
        Textbook: Additional Readings: Cunningham, W. P. & Cunningham, M. A. (2011). *Principles ofenvironmental science: Inquiry and applications* (6th Ed.) New York: McGraw-Hill. www.mhhe.com/cunningham6e
        Reading assignments are listed in the course schedule. The following books will be on reserve in the library for assigned readings:
        Carson, Rachel. (1962). *Silent Spring*. New York: Houghton Mifflin.
        Leopold, Aldo. (1949). A Sand County Almanac, and Sketches Here and There. New York: Oxford University Press.
        Sharp, Z. (2010/2011). *Annual Editions*: *Environment* (29th *ed.).* New York: McGraw-Hill Publishers.
        Wilson, E. O. (2002). *The Future of Life*. New York: Random House.
        Learning Outcomes: At the successful completion of this course students will be able to:

- Explain the fundamental principles of environmental biology and ecology
- Discuss the issues related to human impact on ecosystems
- Discuss and make informed decisions on societal issues related to science and technology in keeping with the NSTA's Position on Teaching Science and Technology in the Context of Societal and Personal Issues, http://www.nsta.org/about/positions/societalpersonalissues.asp
- Engage in class content and have experiences which are in keeping with William Carey University's Mission Statement "to challenge the individual student to excel in scholarship, leadership, and service in a diverse global society."

    Course Work, Assessments Descriptions:
- Three or four exams will cover assigned textbook chapters and readings. The final exam may contain a cumulative section. Exams will be composed of objective type questions.
- Reading assignments will be from original works on environmental ethics on reserve in the library. Students will write a summary reflection of the work with responses directed to the content of the course. Summaries will be no less than 2 pages typed, doubled spaced, APA style. These are due within one week of assignment.

- You will choose one endangered species to research from a list that I will provide. Describe the species' role in the ecosystem, its threats, and possible interventions. You will receive a handout on requirements and grading points.
- A service learning project is designed for 3 to 4 students working in small groups to identify a situation on campus or in the community that is environmentally unfriendly and affect change. As a group you will write a summary on why the situation poses a problem, you will propose a solution and argue why it will be successful. Your group will implement the solution or strategy. You will document your group's progress twice weekly during lab. You will be graded on the written portion of the project, the rationale of the project and the amount of effort your group expended. At the end of the trimester your group will present a short power point presentation to the class on your group's service learning project.
- You will need to purchase a small 3 ring journal and field notebook for the field trips and the lab component of the class. You will record your name, date, time, and location. You will record your observations, sketches, data, maps, etc. Be as neat as possible.

APPENDIX G

SERVICE-LEARNING PROJECT

ENVIRONMENTAL SERVICE-LEARNING PROJECT

GOALS AND OBJECTIVES:
- To enhance student learning of course content and objectives
- Integration of course theory to practice
- Contributing to solutions for environmental problems and community needs
- Promote the mission statement of William Carey University for scholarship, leadership, and service in a diverse global society
- Develop critical thinking and problem solving skills
- Encourage collaborative work that is valued in the workplace

DESCRIPTION:
Students will work in small groups to develop and implement an environmental service-learning project of approximately 4 weeks duration. This project must be approved by the instructor and carried out in a professional, safe and collaborative manner. Each student is expected to attend meetings, respond to communications, and contribute to the project.

The instructor will provide initial guidance, approval and periodic assessment of progress. However, this is your project.
GROUP ASSESSMENT will be based on:
- Group Portfolio (35 points) that will provide documentation and a record of group activities and plans. A log is required of all activities including dates and times (5 points). Project objectives and goals must be included. Suggested documentation could include drawings, plans, photographs or video of the timeline of the project.
- Group Presentation/discussion (10 points) given to the class or other approved group.
INDIVIDUAL ASSESSMENT will be based on:
- Self and Peer Evaluation (25 points). Self-assessment scale score combined with group member assessment. You will receive a copy of the rubric.
- Environmental Service-Learning Journal (50 points)
Journal Overview. Keeping a journal will be an important part of your learning experience. By having you think about what you are doing and what you are learning from the experience, the writing of a journal can increase the amount you actually learn. It can also make you aware of what you don't know, so that you can direct your efforts towards finding out more.
Instructions. Make a journal entry each time you meet or work on the environmental service- learning project. Take a few minutes before you leave the site to make your entry or do it within a few hours of your experience to facilitate making an accurate entry. Journals will be collected within 4 days after the end of the service-learning project. Each journal entry should include all of the following elements (A=

affective component or attitudes), (B= behavior or actions), and (C= cognitive or knowledge). Please clearly divide each entry into the following categories:

1. Date and hours worked (1 point)
2. Objective description of your experiences (3 points). What happened? Write a factual account of behaviors or events that does not include your opinion (B).
3. Interpretation/ Explanation/Connections (3 points). Use the principles, concepts and objectives from the course lectures and reading material in making your connections (C).
4. Personal Opinions/Feelings/ and Learning (3 points). Describe your opinions or feelings on your experience today (A). What knowledge or skills did you acquire today (C or B)? What did you learn today (C)? What do you need to learn (C)? Environmental Service Learning Project Ideas

   Potential Partners:

- William Carey University
- Tradition Development
- Sandhill Crane Refuge. www.fws.gov/mississippisandhillcrane
- Gulf Islands National Seashore.
- Audubon Pascagoula Nature Center. http://pascagoulariver.audubon.org/about-us
- Green Campus. www.nwf.org/global-warming/Campus-solutions.asp
- Association for the advancement of sustainability in higher education. http://www.aashe.org/
   Possible Projects: You may consider these but take some time to brain storm your own ideas. All projects must be approved by me.
- Tradition trail signage
- WCU bird houses
- Butterfly garden and bird feeding areas
- Frog/Amphibian Monitoring Program
- Audubon's Citizen Science
- Inventory of trees and animals on WCU Campus
- Habitat restoration and trail on WCU Campus
- Stream cleaning project
- Removal of invasive species from WCU Campus
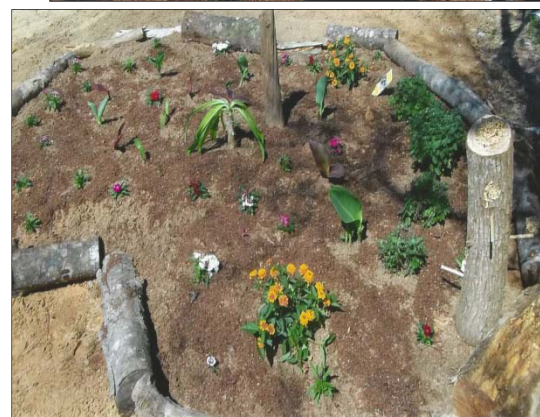- Development of an Educational Program

APPENDIX H

ADDITIONAL PHOTOGRAPHS

Raccoons at work

MINI DGC   19 APR 12   03:19 AM

Small deer and Red Fox Scat

APPENDIX I

MISSISSIPPI SANDHILL CRANE REFUGE FIELD EXPERIENCE

Sandhill Crane Refuge Field Assignments based on 5E Model

Goals:

- Engage students in local native habitat study

- Understand the importance of conservation efforts

    Develop conceptual knowledge related to: species extinction, endangered

species,umbrella and keystone species, invasive species, ecosystems, succession,

biodiversity

Photo By USFWS

A. Pre-Field Assignment.

Research the answers to the following questions and turn in via D2L before your field trip to the Sandhill Crane Refuge.

1. How is a refuge different from a national park?

2. Describe the characteristics of a pine savannah?

3. What makes this habitat different or special?

4. What is difference between an endangered species and a threatened species?

5. List one fact that you know about the Sandhill Cranes or the Refuge.

6. Describe something that you would like to learn or find out from your field experience to the Refuge.

B. Field Assignment and Experience

For this assignment you will need a cell phone with a camera or a digital camera. Bring a notebook to take field notes, binoculars if you have them. (Be sure to take water, sunscreen and bug protection).

You will need approximately 2 1/2 to 3 hours to complete the field work once on the site. Using the map and directions provided at the web link below travel via I-10 to exit 61, turn north approximately one mile on the right to the Sandhill Crane Refuge.

http://www.fws.gov/mississippisandhillcrane/pdfs/SandhillCraneFacts.pdf

1. Stop at the kiosk to on your right for an orientation and map to the area.

2. Proceed to the Visitors Center on the right. View the 12 minute video at the Visitor's Center on the Endangered Sandhill Cranes. After viewing the video spend time in the remainder of the interactive museum exhibits. Take notes for the post field assignment questions.

3. <u>The Scavenger Hunt.</u> In this assignment you will prepare a small notebook or folder with photographs from your scavenger hunt with accompanying common and scientific names and 2 or 3 facts on the species for each photo.

     Go the C. L. Dees Wildlife Trail across from the Visitors Center for the next assignment(You will need your cell phone or camera). Find as many of the following that you can from each category and document by taking a photograph; be sure to have at least one species represented from each category. Be sure to include a personal identifier in the photo such as a card with your name on it.

     <u>Trees:</u> longleaf pine, pond or bald cypress, live oak

     <u>Shrubs or smaller plants:</u> saw palmetto, fern, broadleaf cattail, yaupon holly

     <u>Grasses:</u> toothache grass, wiregrass, bushy broom grass

     <u>Flowers:</u> orchid, hatpin, Virginia Iris, yellow eyed grass, spiderwort, sunflower, hibiscus, orange candy root, meadow beauty, golden rod

     <u>Carnivorous plants:</u> pitcher plants (be sure to identify which one, there are many types), dwarf sundew, thread leaf sundew, spoon leaf sundew, yellow butterwort

     <u>Invasive Species:</u> cogon grass, torpedo grass, Chinese tallow tree, water hyacinth, Japanese honeysuckle

     Extra Points for photo of: Sandhill crane

C. **Post Field Assignment.** In addition to the photograph notebook from the

scavenger hunt answer the following questions related to the Visitors Center

Museum or field experience:

1.   Do refuges, such as the Sandhill Crane Refuge, only benefit or protect one

species?

2. What is the Endangered Species Act of 1973?

3. How much of the original wet pine savannah habitat remains today?

4. How is the wet pine savannah different from other types of vegetation

commonly seen in this region (note especially the understory)?

5. What is the role of fire, natural and prescribed, in the maintenance of pine

savannah habitat?

6. Who was Jake Valentine? What was his impact on the protection of the

Sandhill cranes?

7. How are invasive and exotic species harmful to native habitats?

8. Describe the biodiversity of the wet pine savannah.

9. What is an umbrella species?

10. Identify or describe some examples of human interventions that are beneficial to the Sandhill Crane or its habitat.

11. List and describe some of the identifying characteristics and behaviors of the Sandhill Crane, *Grus canadensis pulla.*

12. Do you have any final observations or personal thoughts on your field experience to the Sandhill Crane Refuge?

APPENDIX J

ENDANGERED SPECIES PROJECT

Endangered species and biodiversity: a classroom project and theme

Brook Lauro, Ph.D.

Associate Professor of Biology

Department of Computer Science, Mathematics and Science

College of Professional Studies

St. John's University

Jamaica, NY 11439

laurob@stjohns.edu

718-990-7475

Please send correspondence to my home address at:

3020 Bridge Lane

Cutchogue, N.Y. 11935

631-734-8337

Section:HOW TO DO IT

Abstract. Students discover the factors contributing to species losses world-wide by conducting a project about endangered species as a component of a larger classroom theme of biodiversity. Groups conduct research using on-line endangered species databases and present results to the class using PowerPoint. Students will improve computer research abilities as well as develop organizational, writing and public speaking skills. This topic may be used at all educational levels by adjusting the difficulty of the content.

Teaser sentence. To learn about threats to biodiversity students conduct group research projects using endangered species databases.

Key Words: Biodiversity; endangered species; extinction; conservation; environmental ethics.

The loss of species diversity is one of the most concerning environmental issues facing the biosphere today and as a result the UN has declared 2010 "*The Year of Biodiversity*". The rate of species loss is so high that experts suggest we are entering the 6th mass extinction event for the planet (Pimm et al., 1995; Leakey & Lewin, 1996;Wilson 2002). As educators we can help sensitize students to the problem so that they may become educated citizens able to make informed decisions, for example, when voting. This may be accomplished with a project on endangered species as a component of a larger classroom theme of biodiversity. This topic may be utilized at all educational levels by adjusting the difficulty of the content.

Biodiversity, short for biological diversity, is that impressive and wondrous aspect of life: from genes, to species, to ecosystems. The number of species discovered to date, according to the *Global Biodiversity Assessment* produced for the United Nations is somewhere between 1.5-1.8 million (Heywood 1996). A low estimate for the actual number alive is approximately 4 million. Yet when small organisms, such as bacteria, protists, and insects, are taken into account the number of species on earth may be as high as a 100 million or more (Parker 1982, Wilson, 1988, Heywood 1996). Sadly, the current rate of loss is likely hundreds, possibly thousands of times higher than the natural background rate of 1 species/million/year (Wilson 2006). As a consequence many species and their special values are being lost before they have been discovered and if

nothing is done we may lose half of the planet's species by the end of the century (Wilson 2002). Edward Wilson's trilogy, *The Diversity of Life*, *The Future of Life*, and *The Creation* (1999, 2002, 2006) provide a helpful overview of this subject and are the basis for modern biodiversity conservation.

For a non-major scientific inquiry course taught at St. John's University the path of biodiversity is studied from its evolutionary beginnings some 3.8 billion years ago when the first cells develop, through species adaptive radiations and mass extinctions, to current day losses of diversity. To provide an in depth understanding of biodiversity and the factors influencing its decline, an inquiry based project is assigned where students work in groups to create PowerPoint presentations on endangered species. Alternatively, poster presentations may be created and shared with the class or school. A project theme is selected each semester and is based upon geographic biome, for example: Amazonian rainforest or African savannah.

The project begins with a background lecture on factors making species vulnerable to extinction (Primack 2010) including: large species with low reproductive potential, species with high economic value and species that live on islands. The class learns about how the exponential growth of the human population impacts species, for example, through habitat loss, the introduction of invasive species and global warming. Groups work cooperatively on internet research using on-line databases for endangered species. Students improve computer skills through their research and presentations as well as develop organizational, writing and public speaking abilities. A fitting time for presentations is Earth Day (April 22nd) or Endangered Species Day (May 15th).

Objectives

- Teach students how to use an inquiry based approach to understand the factors influencing the decline of biodiversity worldwide.
- Sensitize students to the plight of endangered species around the world, emphasizing the value of species and environmental ethics.
- Help students appreciate the complex socio-political nature of endangered species conservation.
- Improve computer skills, as well as group research, writing and public speaking ability.

- Provide students with the knowledge necessary to make educated decisions about biodiversity concerns, for example, when voting in elections or when making purchases of products that may impact endangered species.

Project Outline

1) Students organize into groups of two. Each group selects an endangered species to profile of their own choosing or from a list provided.

2) An electronic species factsheet is made available (http://facpub.stjohns.edu/~laurob/) and acts as an outline for presentations. It includes taxonomic, geographic, ecological and conservation information for species. Students complete the factsheet based upon their independent research and web sites provided (see list below). On the day of the presentation the completed factsheet for each group is distributed to all members of the class.

3) Students are required to use multiple sources of information including: science journals and magazines, newspapers, books and internet sites (see below).

4) Once the factsheet is completed students are given one class period to work on their presentations using their university laptops. It is during this time that problems are discussed and worked out including assistance to create PowerPoint slides.

5) On the day of the presentations worksheets are provided to students to complete as talks area given, helping them to stay engaged. Everyone receives a blank world map to locate species discussed. In addition, a table is provided to record factors influencing why profiled species are vulnerable to extinctions. From this a chart is produced.

6) Students are graded using a rubric provided to them in advance that evaluates their talk, presentation print out, species factsheet, map,chart and final summary.

Enrichment activity: why do species have value?

To support the project an activity is conducted where the class divides into groups of five to discuss why species have value and to consider whether limits need to be placed on protecting endangered species. After students have time to work out their thoughts a classroom discussion ensues where lists are made on the board.

The activity is premised by a homework assignment where independent internet research is conducted about why species have value. In addition, web sites are provided to read (see links below) for a case study about an endangered species controversy such as the Snail Darter of Tennessee or the Spotted Owl of the Pacific Northwest (Murchison 2007, Primack 2010).

Ultimately students discover that species provide us practical or instrumental values since they give us the necessities for life such as: oxygen to breath, food to eat, medicines to treat disease. In addition, students realize that species provide us with a less tangible, but no less important value, intrinsic value, based upon respect for life, beauty and spirituality. A realization for students is that species do go extinct naturally, but man is escalating the process, and in these situations conservation may become necessary. Ultimately, students discover that protecting endangered species is in large part an ethical matter (Wilson 1984, 1999, 2002, Kellert 1996).

Links of Interest

For the project students are required to visit the following web sites in addition to their independent research to gather information for species profiled.

Background Information

- Endangered Species Project: http://facpub.stjohns.edu/~laurob/.
  - This site, created by the author, makes available forms used for the project and provides useful links to information including those below.
- United Nations International Year of Biodiversity 2010: http://www.cbd.int/2010/welcome/ .
  - Useful background information including an informative video is available at this site.
- Field Museum (Chicago, Illinois) web site on biodiversity: http://www.fieldmuseum.org/biodiversity/intro.html.
  - This site provides user friendly background information on the subject of biodiversity.
- Interview with E.O. Wilson by Bill Moyers on PBS: http://www.pbs.org/moyers/journal/07062007/watch.html.

- o This broadcast provides a useful review of the subject of biodiversity by a leader in the field. Students are required to listen to the interview as background.

  Why do species have value?

- Why save endangered species?

  http://www.fws.gov/endangered/pdfs/Why_Save_End_Species_July_2005_spa.pdf

  - o A pamphlet made available electronically by the US Fish and Wildlife Service which gives a helpful overview of endangered species conservation.

- Ethics and the Spotted Owl Controversy

  http://www.scu.edu/ethics/publications/iie/v4n1/

  - This article by Claire Andre and Manuel Velasquez provides a useful synopsis about the conservation debate for this endangered species.

    Endangered Species Databases

- IUCN (InternationalUnion for Conservation of Nature) Red List:

  http://www.iucnredlist.org/.

  - o The Red List is an international system that evaluates and assigns conservation listing status (for example, endangered vs. threatened) for species.

  - o This site has a useful database that students use to complete factsheets for species that includes: listing status, taxonomy, geographic location, and ecology.

  - o Students are required to explain the IUCN Red List status for species profiled.

- CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora): http://www.cites.org/.

  - o An international agreement amongst 175 countries whose aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. It places international sanctions on the trade of endangered species body parts such as, elephant ivory, rhinoceros horn and tiger skin and bones.

- o Students are required to explain whether CITES applies to the species they profile.
- US Fish & Wildlife Service (FWS), Endangered Species site: http://www.fws.gov/endangered/.
  - o The FWS is the lead agency in the United States, empowered by the Endangered Species Act of 1973, to protect species within the country and around the world. It evaluates and lists, develops detailed recovery plans, and protects habitats for species. It is also responsible for protecting species from harm, "taking" or trade, both nationally and internationally.
  - o Students visit this site to examine if and how the FWS protects their species, comparing it with the IUCN Red List that may be different.
- Biodiversity Hotspots: http://www.biodiversityhotspots.org/.
  - o Biodiversity hotspots are regions of conservation concern around the world since they have a high number of endemic vascular plants (at least 1,500) but have lost at least 70 percent of their original habitats. Students are required to determine if their species is located in a biodiversity hotspot and if so they need to describe it to the class.

References and Additional Resources

Andre, C. & Velasquez, M. (2010). Ethics and the Spotted Owl Controversy.
[Online.] Available at http://www.scu.edu/ethics/publications/iie/v4n1/.

Avise, J., Hubbell, S. & Ayala, F. (2008). In the light of evolution II: Biodiversity
and extinction. Proceeding of the National Academy of Sciences, 105, 11453-11457.

Biodiversity Hotspots. (2010). [Online.] Available at
http://www.biodiversityhotspots.org/.

Convention on International Trade in Endangered Species of Wild Fauna and
Flora (CITES). (2010). [Online.] Available athttp://www.cites.org/.

Encyclopedia of Life. (2010). [Online.] Available at http://www.eol.org.

Field Museum. (2010). Biodiversity and Conservation: the Web of Life. [Online.]
Available athttp://www.fieldmuseum.org/biodiversity/intro.html.

Heywood, V. (1996). Global Biodiversity Assessment. Cambridge, UK:
Cambridge University Press.

InternationalUnion for Conservation of Nature (IUCN). (2010).Red List for
threatened species. [Online.] Available at http://www.iucnredlist.org/.

Kellert, S. (1996). The value of life. Washington, D.C.: Island Press.

Lauro, B. (2010). Endangered Species Project. [Online.] Available at
http://facpub.stjohns.edu/~laurob/

Leakey, R. & Lewin, R. (1996). The Sixth Extinction: Patterns of Life and the
Future of Humankind. New York, NY: Anchor Books.

Murchison, K. (2007). The Snail Darter Case TVA versus the Endangered Species
Act. Lawrence, KS: University Press of Kansas.

Parker, S. (1982). Synopsis and Classification of Living Organisms. New York: McGraw-Hill.

Pimm, S.L., Russell, G.J., Gittleman, J.L. & Brooks, T.M. (1995). The Future of Biodiversity. Science, 269, 347-350.

Primack, R.B. (2010). Essentials of Conservation Biology - fifth edition. Sunderland, MA: Sinauer Associates, Inc..

Public Broadcasting Station (PBS). (2010). Bill Moyers Journal, Bill Moyers talks with E.O. Wilson. [Online.] Available athttp://www.pbs.org/moyers/journal/07062007/watch.html.

United Nations International Year of Biodiversity 2010. (2010). [Online.] Available athttp://www.cbd.int/2010/welcome/.

U.S. Fish & Wildlife Service. (2010). Endangered Species Program. [Online.] Available athttp://www.fws.gov/endangered/.

Wilson, E. O. (1984). Biophilia. Cambridge, MA: Harvard University Press.

Wilson, E. O. (1988). The current state of biodiversity. In Wilson, E.O. (Ed.), Biodiversity (pp. 3-20). Washington, D.C.: National Academy Press.

Wilson, E. O. (1999). Diversity of Life. Cambridge MA: Harvard University Press.

Wilson, E.O. (2002). The Future of Life. New York, NY: Alfred A. Knopf .

Wilson, E.O. (2006). The Creation. New York, NY: Norton and Co.

REFERENCES

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50,* 179-211.

Aronson, K. R., Webster, N. S., Reason, R., Ingram, P., Nolan, J., Mitchell, K., & Reed, D.(2005). In S. Root, J. Callahan, & S. H. Billig (Eds.), Using randomized control field trials in service-learning research. In *Improving Service-learning Practice: Research on models to enhance impacts* (pp. 141-165). Charlotte, NC: Information Age.

Astin, A. W., Vogelsang, I. J., Ikeda, E. K., & Yee, J. A. (2000). *How service learning affects students.* Los Angeles, CA: Higher Education Research Institute, UCLA. Retrieved from http://heri.ucla.edu/PDFs/HSLAS.PDF

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (pp. 71-81). New York, NY: Academic Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York, NY: W. H. Freeman.

Battistoni, R. (2006). Approaching democratic engagement: Research findings on civic learning and civic practice. In *Advancing Knowledge in Service-Learning to Transform the Field*,3-16. Greenwich, CT: Information Age.

Billig, S. H. (2000, May). Research on K-12 school-based service-learning: The evidence builds. *Phi Delta Kappan, 81*(9), 658-654.

Billig, S. H., Root, S. & Jesse, D. (2005). The relationship between the quality indicators of service-learning and student outcomes: Testing professional wisdom. In *Improving Service-Learning Practice: Research on models to enhance impacts* (97-115). Greenwich, CT: Information Age.

Boise State University Service-Learning. (2012). *The ABCs of reflection.* Retrieved from
http://service-learning.boisestate.edu.

Bowen, G. (2010). Service learning in the scholarship of teaching and learning: Effective
practices. *International Journal for the Scholarship of Teaching and Learning,
4*(2), 1-15.

Boyle-Baise, M., Brown, R., Hsu, M., Jones, D., Prakash, A., Rausch, M., . . . Walquist,
Z. (2006). Learning service or service learning: Enabling the civic. *International
Journal of Teaching and Learning in Higher Education, 18* (1), 17-26.

Bradley, L. R. (2003). Using developmental and learning theory in the design and
evaluation of K-16 service-learning programs. In S. Billig & J. Waterman (Eds),
Studying Service-Learning: Innovations in Educational Research Methodology
(pp. 47-72). Mahwah, NJ: Lawrence Erlbaum.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of
learning. *Educational Researcher, 18*(1), 32-42.

Bruner, J. (1966). *Toward a theory of instruction*. Cambridge, MA: Harvard University.

Bybee, R. W. (1979). Science education and the emerging ecological society. *Science
Education, 63*, 95-109.

Bybee, R. W. (2010). *The teaching of science: 21st century perspectives*. Arlington, VA:
NSTA.

Callicott, J. B. (2013, January 25). *From land ethic to earth ethic* [Lecture presentation].
Hattiesburg, MS: University of Southern Mississippi.

Carson, R. (1962). *Silent Spring.* New York, NY: Houghton Mifflin.

Checkley, K. (1997). The first seven…and the eighth. *Educational Leadership, 55*(1), 8-
13.

Cone, R., & Harris, S. (1996). Service-learning practice: A theoretical framework. *Michigan Journal of Community Service Learning*, *3*, 31-43.

Connell, S., Fien, J., Lee, J., Sykes, L., & Yencken, D. (1999). 'If it doesn't directly affect you, you don't think about it': A qualitative study of young people's environmental attitude in two Australian cities. *Environmental Education Research, 5*(1), 95-104.

Conville, R., & Weintraub, S. (Eds.). (2001). Service-learning and communication: A disciplinary toolkit. Washington, DC: National Communication Association. Retrieved from www.cnu.edu/engage/docs/ToolkitforFaculty.pdf

Correia, M. G., & Bleicher, R. E. (2008, Spring). Making connections to reach reflection. *Michigan Journal of Community Service Learning,* 41-49. Retrieved from http://www.infoagepub.com/Understanding-Service-Learning-and-Community-Engagement

Covitt, B. A. (2003). Motivating environmentally responsible behavior through service learning. Washington, DC: Corporation for National and Community Service. Retrieved from http://www.nationalserviceresources.org/files/r2260-motivating-environmentally-responsible-behavior.pdf

Coyle, K. (2005). Environmental literacy in America: What ten years of NEETF/Roper from Research & related studies say about environmental literacy in the U.S. Retrieved from www.neetf.org

Creswell, J. W. (2009). *Research design: Qualitative, quantitative and mixed methods approaches.* Los Angeles, CA: Sage.

Cunningham, W. P., & Cunningham, M. A. (2011). *Principles of environmental science: Inquiry and applications.* New York, NY: McGraw Hill.

DeBoer, G. E. (1991). *A history of ideas in science education: Implications for practice*.

New York, NY: Teachers College Press.

Dewey, J. (1933). *How we think*. Boston, MA: Heath.

Dewey, J. (1938). *Experience and education*. New York, NY: Collier.

Dewey, J. (1954). *The public and its problems.* Denver, CO: Allan Swallow.

Diekmann, A., & Preisendorfer, P. (1998). Environmental behavior. *Rationality and Society, 10*(1), 79-103.

England, Y. A., & Marcinkowski, T. (2007). Environmental service-learning programs in Florida high schools and colleges: Nature, status, and effects as demonstrated by a statewide program census. *Journal of Environmental Education, 38*(4), 51-60. doi: 10.3200/JOEE.38.4.51-60

Esa, N. (2010). Environmental knowledge, attitude and practices of student teachers. *International Research in Geographical and Environmental Education, 19*(1), 39-50.

Eyler, J., & Giles, D. E. (1999). *Where's the learning in service-learning?* San Francisco, CA: Jossey-Bass.

Eyler. J., Root, S., & Giles, D. E., Jr. (1998). Service-learning and the development of expert citizens: Service-learning and cognitive science. In R. Bringle & D. Duffey (Eds.), *With service in mind: Concepts and models for service-learning in psychology*(pp. 85-100). Washington, DC: American Association for Higher Education.

Furco, A., & Root, S. (2010). Research demonstrates the value of service learning. *Kappan, 91*, 16-20.

Garner, H. (1987). *The mind's new science*. New York, NY: Basic Books.

Giles, D. E., & Eyler, J. (1994a). The impact of a college community service laboratory on students' personal, social, and cognitive outcomes. *Journal of Adolescence, 17*, 327-339.

Giles, D. E., & Eyler, J. (1994b). The theoretical roots of service-learning in John Dewey: Toward theory of service learning. *Michigan Journal of Service Learning, 1*, 77-85.

Green, P. L. (1997). *The effect of participation in a "Greening the BCC Curriculum" workshop series on the environmental literacy of a community college faculty.* Unpublished dissertation, Florida International University, Miami, Florida.

Haines, S. (2003). Informal life science: Incorporating service learning components into biology education. *Journal of College Science Teaching, 32*(7), 440-442.

Haines, S. (2010). Environmental education and service learning in the tropics: Making global connections. *Journal of College Science Teaching, 39*(3), 16-23.

Hamilton, S. & Zeldin, R. S. (1987). Learning civics in the community. *Curriculum Inquiry, 17*(4), 407-420.

Handa, V., Tippins, D., Thompson, N., Bilbao, P., Morano, L., Hallar, B., & Miller, K. (2008). A dialogue of life: Integrating service learning in a community in a community-immersion model of pre-service science teacher preparation. *Journal of College Science Teaching, 37*(6), 14-20.

Harkavy, I. & Hartley, M. (2010). Pursuing Franklin's Dream: Philosophical and historical roots of service-learning. *American Journal of Community Psychology, 46*, 418-427. doi: 10.1007/s10464-010-9341-x.

Hatch, J. A. (2001). *Doing qualitative research in education settings.* Albany, NY: State University of New York Press.

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1986-1987). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education, 18*(2), 1-8.

Hobart, T. M. (2010). A follow-up study of Eco Education's environmental service-learning *program* (Doctoral dissertation). Retrieved from *Dissertations & Theses: Full Text* (Publication No. AAT 3434268).

Hungerford , H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. *Journal of Environmental Education, 21*(3), 8-22.

Kaiser, F. G., Wolfing, S., & Fuhrer, U. (1999). Environmental attitude and ecological behavior. *Journal of Environmental Psychology 19*, 1-19.

Kennedy, E. H., Beckley, T. M., McFarlane, B. L., & Nadeau, S. (2009). Why we don't "walk the talk": Understanding the environmental values/behaviour gap in Canada. *Human Ecology Review, 16*(2), 151-160.

Kibert, N. C. (2000). *An analysis of the correlations between the attitude, behavior, and knowledge components of environmental literacy in undergraduate university students*. Unpublished thesis, University of Florida, Gainesville, FL.

Kolb, D. A. (1984). *Experiential learning.* Englewood Cliffs, NJ: Prentice Hall.

Kuhlemeier, H., Van Den Bergh, H., & Lagerweij, N. (1999). Environmental knowledge, attitudes and behavior in Dutch secondary education. *Journal of Environmental Education, 30*(2), 4-15.

Lauro, B. (2010). *Endangered species and biodiversity: A classroom project and theme*. Retrieved from http://facpub.stjohs.edu/~laurob/

Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. Cambridge, UK: Cambridge University.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York, NY: Cambridge University.

Leege, L., & Cawthorn, M. (2008). Environmental service learning: Relevant, rewarding, and responsible. *Journal of College Science Teaching, 37*(6), 32-36.

Leopold, A. (1949). A *Sand County Almanac, and sketches here and there*. New York, NY: Oxford University.

Lieberman, G. A., & Hoody, L. L. (1998). Closing the achievement gap: Using the environment as an integrating context for learning. Poway, CA: Science Wizards. Retrieved from http://www.seer.org/extras/execsum.pdf.

MacFall, J. (2012). Long-term impact of service learning in environmental studies. *Journal of College Science Teaching, 41*(3), 26-31.

Markus, G., Howard, J., & King, D. (1993). Integrating community service and classroom instruction enhances learning: Results from an experiment. *Educational Evaluation and Policy Analysis, 15*(4), 410-419.

Monroe, M. (2003). Two avenues for encouraging conservation behaviors. *Human Ecology Review, 10* (2), 113-125.

Moore. M. C. (2003). Two avenues for encouraging conservation behaviors. *Human Ecology Review, 10*(2), 113-125.

National and Community Service Act of 1990. Retrieved from https://www.nationalservice.gov%2fpdf%2f1990_serviceact_as%2520amended%2520through%2520pl%2520111-13.pdf

National Service-Learning Clearinghouse. (2012). *What is service-learning?* Retrieved from http://servicelearning.org

National Youth Leadership Council. (2008). *K-12 service learning standards for quality*

practice. Retrieved from http://www.nylc.org/k-12-service-learning-standards-quality-practice.

Newman, J. (2008). Service learning as an expression of ethics. *New Directions of Higher Education, 142,* 17-24. doi: 10.1002/he.300

North American Association for Environmental Education. (2011). *Promoting excellence in environmental education*. Retrieved from www.naaee.net/framework

Packer, A. (2009). Service learning in a non-majors biology course promotes changes in students' attitudes and values about the environment. *International Journal for the Scholarship of Teaching and Learning, 3*(1), 1-23.

Rands, G. P. (2009). A principle-attribute matrix for environmentally sustainable management education and its application: The case for change-oriented service-learning projects. *Journal of Management Education 33*(3), 296-322. doi: 10.1177/1052562908323191.

Roth, C. E. (1992). *Environmental literacy: Its roots, evolution, and direction in the 1990s*. Columbus, OH: Eric Clearinghouse for Science, Mathematics and Environmental Education.

Scott, J. C. (2006). The mission of the university: Medieval to postmodern transformations. *Journal of Higher Education 77,* 1-39.

Scott, D., & Willits, F. K. (1994). Environmental attitudes and behavior. *Environment and Behavior, 26*(2), 239-261.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22*, 63-75.

Sobel, D. (2004). *Place-based education: Connecting classrooms and communities*. Great Barrington, MA: Orion Society.

Thomson, A. M., Smith-Tolken, A. R., Naidoo, A. V., & Bringle, R. G. (2011). Service learning and community engagement: A comparison of three national contexts. *Voluntas, 22*, 214-237. doi: 10.1007/s11266-010-9133-9.

United Nations Educational, Scientific, and Cultural Organization. (2012). Retrieved from www.unesco.org

Vygotsky, L. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University.

Welch, M. (1999). The ABCs of reflection: A template for students and instructors to implement written reflection in service-learning. *National Service-learning E.E. Quarterly, 25*(2), 23-25.