EFFECT OF SUSTAINABLE DESIGN LEARNING CYCLE 
ON CONSTRUCTION STUDENTS’ REPORTED ATTITUDES, 
REPORTED BEHAVIORS, AND KNOWLEDGE 
REGARDING SUSTAINABILITY 
A THESIS 
SUBMITTED TO THE GRADUATE SCHOOL 
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS 
FOR THE DEGREE 
MASTER OF ARTS IN TECHNOLOGY EDUCATION 
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JULY 2010
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Chapter 1: Introduction

Global climate change, and specifically “global warming,” are being discussed more now than ever before. According to the U.S. Global Change Research Program (2009), “human activities have been releasing additional heat-trapping gases, intensifying the natural greenhouse effect, thereby changing the Earth’s climate” (p. 14). This increased discussion of global climate change has led to a heightened discussion of sustainability and how individuals can make environmentally responsible decisions. According to the Environmental Protection Agency (2002), “taking care of our environment for ourselves and future generations is a responsibility for all of us” (p. 28).

Students have the ability to take home what they learn at school and share it with their friends and family. As Gore (2006) states, “unless we act boldly and quickly deal with the underlying causes of global warming, our world will undergo a string of terrible catastrophes” (p.10). The ability of our students to take instruction on sustainability and pass on the knowledge to others could help our nation to deal with the causes of global warming.

Introduction to the Problem

The United Nations General Assembly (1987) defined sustainability as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (¶ 2). Oskamp (2002) has outlined four key domains of sustainability.
The first domain is listed as ecological, with a principle of “stability of environmental processes, so that human impacts do not prevent the environment from replenishing itself” (Oskamp, 2002, p. 306). The second listed domain is social, with a principle of “diminished disparities of distribution of the world’s resources in the present (intragenerational justice) and preserving those resources for the future (intergenerational justice)” (Oskamp, 2002, p. 306). The third domain is economic, with a principle of “growth limited to the capacity of Earth’s finite resources and its renewable supplies of material and energy” (Oskamp, 2002, p. 306). Political, institutional, and cultural is the fourth and final domain with a principle “aimed at improving the quality of life for all people, which is to be accomplished through adequate means of public communication and participation, within stable, effective, and honest governments” (Oskamp, 2002, p. 306).

According to the International Technology Education Association (ITEA, 2006), green building is meant to “reduce the environmental effects of the building process” and “includes using environmentally friendly materials and construction techniques” as well as including “design decisions that reduce energy and resource use over the life of the house” (p. 84). If the United States committed itself to green building, there is a potential to create 2.5 million jobs (United States Green Building Council, 2008). The fundamentals of green building directly relate to both the economic and ecological domains of sustainability as outlined in the above and may be incorporated in to construction education.

Descriptive reports and research have been published regarding the inclusion of sustainability in construction curriculum, but was only found at the college level and not
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regarding its impact on students’ reported attitudes, behaviors, and knowledge regarding sustainability. Kibert and Ries (2009) report that the inclusion of sustainability in construction courses at the University of Florida has caused the builders in Florida to be “aware of the issues of high-performance buildings” and the students to be “well versed in the issues of green building” (p. 6). Tinker and Burt (2009) reported that among Associated Schools of Construction (ASC) collegiate programs, “very few universities are currently educating their students on sustainable construction issues” and that there is “a moral and financial responsibility to educate future constructors in sustainable issues” (p. 6).

Leadership in Energy and Environmental Design (LEED) is the most prominent green building standard to date (ITEA, 2006, p. 84). Created by the U.S. Green Building Council (USGBC), LEED is a green building certification system that is internationally recognized and applicable to all building types (U.S. Green Building Council, 2010). In 2009, Brown published a descriptive report regarding the implementation of a course titled “Green Building Practices and LEED Certification” and its effect on college construction student’s ability to achieve the LEED Accredited Professionals (LEED-AP) certification. Brown (2009) reported that “over sixty students that have taken the course have passed the LEED-AP exam” and that following graduation students have written to her to “report how significant it has been for their careers to have prepared for and passed the LEED AP exam before graduating” (p. 6). This suggests a link between instruction on sustainable building practices, specifically LEED, and passing the LEED-AP exam, which shows knowledge gained regarding sustainability but does not assess changes in the students’ reported attitudes or behaviors regarding sustainability.
There are many examples today of sustainability education either being infused in curriculum for another subject or sustainability education as a standalone curriculum, in both technology education and other fields (Cloud Institute for Sustainability Education, n.d.b; The Tahoe Center for a Sustainable Future, 1999; Urban Options Inc., 2004; Vermont Department of Education, 2000; Vermont Education for Sustainability, n.d.). One such curriculum may be the “Seeing Green” learning cycle as part of a larger Construction Technologies learning unit developed by the International Technology Education Association (ITEA) in 2006. The Construction Technologies learning unit uses “hands-on, problem based activities to introduce fundamental technology concepts” (ITEA, 2006, p. v). The “Seeing Green” learning cycle seeks to show students “how current green building trends are changing the way residential buildings are being designed and built” (ITEA, 2006, p.84). Part of this learning cycle focuses on the concept and structure of the LEED certification process for new construction, while also giving students hands-on practice with green building techniques.

If we look back to Oskamp’s (2002) domains of sustainability, we see many mentions of the environment including the discussion of environmental processes in the ecological domain, the world’s resources and their preservation in the social domain, and the earth’s resources as well as renewable supplies of materials and energy in the economic domain. With this in mind, research in the area of environmental education was consulted. There is research that demonstrates that instruction regarding environmental education has the ability to change students’ reported attitudes (Folio, 2002; Martin, 2003; Peck, 2009). In a study by Peck (2009), he found that students’ gained knowledge regarding electric usage as related to carbon footprints, but found it was impossible to
determine if a change in students’ behavior resulted in reduced energy use within the school building (p. 8). Martin (2003) completed a study with elementary school students that found that outdoor schoolyard experiences resulted in an increase in student’s environmental knowledge and comfort. In Folio’s (2005) study, the researcher found that 57% of students felt that it was “very important” to conserve natural resources after a course in environmental studies (p.1). In all three of these studies, it was found that instruction impacted students’ reported knowledge, behaviors, and/or attitudes. In all three studies, in varying forms, the researcher was not just looking at environmental education, but also at sustainability education.

With this in mind, the researcher seeks to determine if instruction regarding sustainability affects students’ reported attitudes, behaviors, and knowledge regarding sustainability. Within this quasi-experimental study, subjects’ knowledge will be measured according to the learning objectives of the treatment and the four domains of sustainability, ecological, social, economic, and political, institutional, or cultural (Oskamp, 2002). Subjects’ reported behaviors and reported attitudes will also be related to and measured according to the four domains of sustainability. Technology education is the chosen contextual field for this study. Along with other educational fields, technology education has space within its standards for addressing the topic of sustainability with students.

Statement of Significance

Secondary construction technology teachers who implement the “Seeing Green” learning cycle in their curriculum are most likely to benefit from this study. These teachers will be able to make more informed decisions regarding the implementation of
the “Seeing Green” learning cycle in their courses and will help them to predict how this instruction might impact students’ related attitudes and behaviors as well as what students might learn as a result of the learning cycle. Research establishing a relationship between instruction regarding sustainability and students’ reported attitudes, behaviors, and knowledge towards sustainability would allow secondary technology education teachers to see the possible benefits of including sustainability instruction in their curriculum, though this learning cycle and research study looks at just a small part of sustainability. Instruction regarding sustainability may result in a change in students’ attitudes and behaviors that impact their choices regarding their own sustainable living practices, as well as their ability to make an impact on those making similar choices around them.

Given the current worldwide concern over global climate change, the results of investigations aimed at attitudes toward sustainability are of growing importance.

**Purpose and Research Question**

The purpose of this quasi-experimental research study was to examine the influence of the “Seeing Green” learning cycle on students’ reported attitudes, reported behaviors, and knowledge changes regarding sustainability. The following research questions were addressed within this study:

- How does a sustainable design learning cycle in a high school construction course affect students’ reported attitudes and reported behaviors regarding sustainability?
- As evidenced by student logbooks, did students gain knowledge in regards to the domains of sustainability and the objectives of the learning cycle?
Definition of Terms

For the purposes of this study, the following relevant terms will be defined as:

**Attitude**: “a predisposition to experience, to be motivated by, and to act toward, a class of objects in a predictable manner” (University of Michigan Department of Psychology, 2006, more recent definitions of attitudes section, ¶ 1). In this study, cognitive and conative attitudes are of interest. Reported attitudes regarding sustainability are measured through students’ answers on a pre and post test titled Student Survey Measuring Sustainability Attitudes and Behaviors.

**Behavior**: “observable activity of an organism; anything an organism does that involves action and/or response to stimulation” (Wallace, Sanders, and Ferl, 1991, as cited in Levitis, Lidicker, and Freund, n.d., p.7). This research looks to study the subjects’ reported behaviors such as how often they turn off light switches when leaving a room and how often they recycle, as well as their behaviors in regards to others. Reported behaviors regarding sustainability are measured through students’ answers on a pre and post test titled Student Survey Measuring Sustainability Attitudes and Behaviors.

**Construction Technology**: “the design and building of structures” (Brusic, Fales, & Kuetemeyer, 2008, p. 323)

**Ecological Domain of Sustainability**: “stability of environmental processes, so that human impacts do not prevent the environment from replenishing itself” (Oskamp, 2002, p. 306)

**Economic Domain of Sustainability**: “growth limited to the capacity of Earth’s finite resources and its renewable supplies of material and energy” (Oskamp, 2002, p. 306). In
other words, a nation’s economic growth is limited by its resources and the stability of its economy is related to the stability of the environment.

**Learning Cycle**: a student method of constructing and applying knowledge and skills while reflecting on what they think they know and extending their understanding to new situations (ITEA, 2006). The learning cycle “Seeing Green” as part of the learning unit titled *Construction Technologies* will be used in its entirety as the treatment for this study (ITEA, 2006).

**Optimum Value Engineering**: construction techniques that “use engineering principles to minimize material usage while meeting model building code structural performance requirements” (ToolBase Services, 2001, ¶ 2)

**Political, Institutional, and Cultural Domain of Sustainability**: “aimed at improving the quality of life for all people, which is to be accomplished through adequate means of public communication and participation, within stable, effective, and honest governments” (Oskamp, 2002, p. 306)

**Residential Construction**: “the building of structures in which people live” (Brusic et al, 2008, p. 327)

**Social Domain of Sustainability**: “diminished disparities of distribution of the world’s resources in the present (intrigenerational justice) and preserving those resources for the future (intergenerational justice)” (Oskamp, 2002, p. 306)

**Sustainability**: “meeting the needs of the present without compromising the ability of future generations to meet their needs” (The United Nations General Assembly, 1987, ¶ 2). In this study, the four domains of sustainability as outlined in 2002 by Oskamp,
economic, ecological, social, and political, institutional, and cultural, were used as a framework to assess students’ knowledge gains in regards to sustainability.

**Sustainable Construction**: “those materials and methods used to construct and maintain a structure that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Tinker & Burt, 2004, p. 26)

**Sustainable Design**: design that “seeks to reduce negative impacts on the environment, and the health and comfort of building occupants, thereby improving building performance” (United States General Services Administration, 2008, ¶ 1)

**Technology Education**: “a study of technology, which provides an opportunity for students to learn about the processes and knowledge related to technology that are needed to solve problems and extend human capabilities” (ITEA, 1995, ¶ 3)

**Assumptions and Limitations**

Given the methods and instruments of this study, assumptions and limitations do exist. It was assumed that the “Seeing Green” learning cycle (ITEA, 2006) utilized was a valid curriculum to address the domains of sustainability. It was also assumed that the coding of the logbook entries according to the domains of sustainability and the learning cycle objectives was as a useful framework to assess the subjects’ knowledge changes as a result of the learning cycle.

The reader should be aware that the results of this study depended on students answering the questions in the pre and post test honestly. This study was also limited by the attitudes of the students enrolled in the course during the time period the study was conducted. Some students may have come to the course with values regarding sustainability already in place. The length of class periods, the varied backgrounds of the
subjects, the previous knowledge of the subjects, and the established course content also limited this study. During the course of the study, the number of logbook entries required of the students as well as the scope of the logbook entries changed, resulting in a limitation of what could be determined by the logbook entries in relation to this study.

Most importantly, it should be noted that the results of this study cannot be generalized to the population given the fact that it was only tested in one course within one school district. Every attempt was made to include sufficient information to allow the reader to determine if this is applicable to their situation. This study was done near the end of the school year when students are often feeling overwhelmed with final exams and projects, which may have affected the outcomes of this study.
Chapter 2: Review of the Literature

The following section is meant to give the reader an overall view of related literature to the research problem. Literature was reviewed in the areas of sustainability including current educational standards regarding sustainability and also in the area of sustainability education including existing sustainability education, current research on environmental education’s relation to student attitudes, examples of sustainability in construction education, and research on sustainability in education settings. The last section of this literature review looks at construction education including LEED, construction technology education in the United States and specifically New York, and descriptive reports on sustainability instruction in construction education.

Sustainability

Again, sustainability can be defined as “meeting the needs of the present without compromising the ability of future generations to meet their needs” (The United Nations General Assembly, 1987, ¶ 2). Many different states, educational institutions, and businesses have developed a sustainability framework to guide their work (Lane Community College, n.d.; Nestlé S.A., 2002; United States Army, 2004; 3M, 2009; Washington State Department of Ecology, n.d.; West Virginia Vision Shared Sustainable Development Team, 2008). Overall, they are all aimed in their own way at fulfilling the above definition of sustainability.
Domains of Sustainability

For the purposes of this research study, Oskamp’s (2002) four domains of sustainability were chosen as the model to assess student learning outcomes from the “Seeing Green” learning cycle instruction. As stated in the introduction to the problem, Oskamp (2002) outlined four key domains of sustainability: ecological including “stability of environmental processes” and impacts that “do not prevent the environment from replenishing itself,” social which can be defined as “diminished disparities of distribution of the world’s resources in the present” and preserving them for the future, economic which includes limiting growth according to the Earth’s resources, and political, cultural, and institutional which is improving all people’s quality of life which should be achieved “through adequate means of public communication and participation, within stable, effective, and honest governments” (p. 306). The ecological domain of sustainability would include such practices as replanting forests and maintaining environments that allow for biodiversity. Examples within the social domain would include addressing the disparities among home building supplies (intragenerational justice) and the rationing of fossil fuels so that they are available for future generations until our world is no longer dependent on them (intergenerational justice). An example of the economic domain would be the responsible use of land as more buildings are raised to address the issue of the world’s growing population. An example within the political, social, and institutional domain would be all levels of government, as well as educational institutions, working to provide information regarding sustainable construction practices that is useful to all citizens.
Other frameworks of sustainability were reviewed by the researcher including those used by companies such as Nestlé S. A. (2002), governmental agencies such as the United States Army (2004), and state agencies including the Washington State Department of Ecology (n.d.). However, after this review, it was determined that Oskamp’s (2002) four domains best related to the “Seeing Green” learning cycle used in this research study as a treatment. An example of a strong relation between the “Seeing Green” learning cycle and Oskamp’s domains of sustainability is the relation of the ecological domain to the information presented on optimum value engineering and green building in the learning cycle. The ecological domain of sustainability includes the principle that “human impacts do not prevent the environment from replenishing itself” (Oskamp, 2002, p. 306) while optimum value engineering includes the idea that builders should “minimize material usage” (ToolBase Services, 2001, ¶ 2). Oskamp’s framework has been widely accepted by others including Reser (2007), Saunders, (2003), Lee (2007), and Ciumasu (2007).

**Sustainability Education**

With in this section of the literature review, standards that address or have the ability to address sustainability will be discussed along with existing examples of sustainability education. In addition, research on environmental education and its impact on student attitudes will be reviewed in this section. Environmental education, according to Martin (2003), includes “learning activities in the outdoors that are designed to develop greater insight into ecological relationships and the need for maintaining the quality of the environment” (p. 51). When comparing this explanation of environmental education to the previously discussed definition and domains of sustainability, the
connection between the environmental education and the domains of sustainability is very clear, allowing us to look at research on environmental education when discussing sustainability education.

*Existing Sustainability Education*

Currently, some examples of sustainability curriculum and instruction do exist. According to Rowe (2007), “sustainability is being integrated into U.S. institutions’ mission and planning, curricula, research, student life, operations and purchasing, and community partnerships (p. 323). Rowe (2007) also states that there is an “infusion of sustainability into the general education core requirements, courses, disciplines, whole colleges, and specialized degrees” (p.323).

Vermont Education for Sustainability (VT-EFS) works to promote “an understanding of the interconnectedness of the economy, the environment, and society” and to integrate sustainability in to K-12 education (n.d., Education for Sustainability section, ¶1). VT-EFS (n.d.) has facilitated the development of 63 units and courses for integrating sustainability in to the classroom and was also instrumental in the addition of two new standards regarding sustainability to the Vermont Framework of Standards and Learning Opportunities, Sustainability and Understanding Place. Standard 3.9: Sustainability, as part of the Personal Development Standards, states that students should “make decisions that demonstrate understanding of natural and human communities, the ecological, economic, political, or social systems within them, and awareness of how their personal and collective actions affect the sustainability of these interrelated systems” (Vermont Department of Education, 2000, p. 3.2). Standard 4.6: Understanding Place, as part of the Civic/Social Responsibility Standards, states that students should
“demonstrate understanding of the relationship between their local environment and community heritage and how each shapes their lives” (Vermont Department of Education, 2000, p. 4.1).

The Cloud Institute for Sustainability Education (n.d.b) has a mission of ensuring “the viability of sustainable communities by leveraging changes in K-12 school systems to prepare young people for the shift toward a sustainable future” (¶ 1). The Cloud Institute for Sustainability Education (n.d.a) has developed “a dynamic system of core content, competencies and habits of mind coupled with a pedagogical system that is learner centered and inquiry based” that includes core contents in areas such as ecological literacy, sustainable economics, and citizenship (¶ 3).

Urban Options Inc. (2004) has created the Sustainability Education Handbook: Resource Guide for K-12 Educators for teachers in the state of Michigan that is meant to help teachers understand and incorporate sustainability in to their classrooms. While writing this handbook, the organization evaluated the Michigan State Framework Standards and Benchmarks in order to identify opportunities for integrating sustainability in to the current curriculum (Urban Options Inc., 2004). This handbook includes sample activities, teaching tools, websites, and other related information for teachers.

In 1999, the Tahoe Center for a Sustainable Future, under the direction of Harriet Goldman, developed a Sustainability Education Guide (1999). This guide was developed to include information teachers need to incorporate sustainability education in to their classrooms including historical contexts, underlying principles, and sample community projects (The Tahoe Center for a Sustainable Future, 1999). This was published as a first draft, but it does not appear that any further publications were made.
Positioning Sustainability in the Curriculum

Given this growing focus on sustainability, it is appropriate to wonder where sustainability education is or could be positioned within our nation’s secondary schools. The Standards for Technological Literacy (STL), produced by the ITEA (2007), are standards for use in United States technology education courses for grades kindergarten through twelve, with an overall goal of having students become technologically literate. According to the ITEA (2007), technological literacy is “the ability to use, manage, understand, and assess technology” (p. 242). Several STs share similar concerns with sustainability principles. STL Standard 5 states “Students will develop an understanding of the effects of technology on the environment” (ITEA, 2007, p.55) while STL Standard 13 states “Students will develop abilities to assess the impact of products and systems” (ITEA, 2007, p.114). STL Standard 5 has six benchmarks at the grades 9 – 12 level including:

- “Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing, and recycling” (ITEA, 2007, p.71)
- “The alignment of technological process with natural processes maximizes performance and reduces negative impacts on the environment” (ITEA, 2007, p.72)
- “Decisions regarding the negative implantation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment” (ITEA, 2007, p.72)
STL Standard 13 has a benchmark at the grades 9-12 level stating that students should be able to “Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment” (ITEA, 2007, p. 138). Given these standards and benchmarks, it seems possible that technology education could be an appropriate venue for teaching students about the impacts technology has on global climate change and sustainable living. It is important students fully realize the impacts that the technologies we have created have on the environment and the planet.

The National Academy of Sciences (NAS) developed science standards for all grade levels in 1994. These standards for grade levels nine through twelve are divided into seven categories: science as inquiry, physical science, life science, earth and space science, science and technology, science in personal and social perspectives, and history and nature of science. According to the science and technology category, “all students should develop abilities of technological design and understandings about science and technology” (NAS, 1994, ¶ 1). Also, according to the personal and social perspectives category, “students should develop understanding of population growth . . . natural resources . . . environmental quality . . . natural and human-induced standards . . . science and technology in local, national, and global challenges” (NAS, 1994, ¶ 1). These standards showcase the clear connection between science and technology, and the connections to sustainability education in science standards as well.

The National Council for the Social Studies (1994) has created ten thematic strands for social studies, two of which relate to sustainability. Strand VIII: Science, Technology, and Society states “Social studies programs should include experiences that provide for the study of relationships among science, technology, and society” (National
Strand IX: Global Connections states “Social studies programs should include experiences that provide for the study of global connections and interdependence” (National Council for the Social Studies, 1994, Global Connections section, ¶ 1). It is possible that sustainability education could also occur while fulfilling these standards.

Given that this study was conducted in New York State, the New York State Learning Standards were also reviewed. Standard 5, Technology, section two is titled “Tools, Resources, and Technological Processes” has a commencement level key idea as “Technological tools, materials, and other resources should be selected on the basis of safety, cost, availability, appropriateness, and environmental impact; technological processes change energy, information, and material resources into more useful forms” (New York State Education Department, 1996, p. 44). Performance indicators at the commencement level from this section of Standard 5 include “Students select appropriate tools, instrument, and equipment and use them correctly to process materials, energy, and information” as well as “Students explain tradeoffs made in selection alternative resources in terms of safety, cost, properties, availability, ease of processing, and disposability” (New York State Education Department, 1996, p. 44). Section Four of the same standard lists the commencement level key idea as “Technological systems are designed to achieve specific results and produce outputs, such as products, structures, services, energy, or other systems” with a corresponding performance indicator stating “Students explain why making tradeoffs among characteristics, such as safety, function, cost, ease of operation, quality of post-purchase support, and environmental impact, is necessary when selecting systems for specific purposes” (New York State Education Department, 1996, p. 44).
Department, 1996, p. 45). Standard 5, Technology, Section Six is titled “Impacts of Technology” with the key idea at the commencement level being “Technology can have positive and negative impacts on individuals, society, and the environment and humans have the capability and responsibility to constrain or promote technological development” (New York State Education Department, 1996, p. 46). The performance indicators for this key idea include “Students explain that although technological effects are complex and difficult to predict accurately, humans can control the development and implementation of technology” (New York State Education Department, 1996, p. 46). Sustainability education within a technology education course could meet these standards and performance indicators.

Research on Environmental Education as Related to Students’ Attitudes

There is current research out regarding the impact of environmental education on students’ attitudes. In 2009, Peck conducted a study “to determine the effects upon student knowledge and perceptions regarding greenhouse gas emissions as a result of an intervention relying upon the submetering the 6th grade wing of a Middle School, displaying the information regarding electrical consumption and carbon footprint, and reducing the electrical consumption of the wing” (p.1). In this study, the sixth grade wing’s electrical use was monitored using power management software which every minute updated the kilowatt hours used as well as the carbon footprint and also showed the kilowatt hour usage from the day before for comparison (Peck, 2009). Peck (2009) reported that through this study, it was determined that the students did gain knowledge related to greenhouse gases, the United States’ emissions of greenhouse gases relative to population, and the amount of carbon dioxide emitted to produce electricity (p. 9). Peck
Peck (2009) also reported a change in students’ perceptions relative to their ability to change greenhouse gas emissions and their plan to continue to reduce greenhouse gas emissions in the future. Overall, it was concluded by Peck (2009) that “submetering the 6th grade wing of Seneca Ridge Middle School combined with collective actions of the students caused significant gains in learning and significant shifts in perceptions by students” and it was recommended “that other schools consider submetering both to save energy and to increase student learning” (p. 9).

In 2003, Martin conducted a study “designed to examine the effects of participation in regular outdoor schoolyard environmental education activities on environmental knowledge, attitudes, behaviors, and comfort levels of fourth- and fifth-grade students” (p. 53). Martin (2003) concluded that the “the adjusted mean posttest scores for the fourth- and fifth-grade treatment groups were higher than the adjusted mean posttest scores for the fourth- and fifth-grade control group for each of the four outcome variables” (p. 56). However, only two outcome areas showed statistically significant results, environmental knowledge including soil samples and tree observations (p. 54) and comfort levels in regards to the outdoors (p.56).

In 2002, Folio examined how an environmental studies course “could change student attitude and behavior in relation to both the discipline of environmental studies and the environment” (p. 1). It was determined that students who already had interest in and commitment to the environment when starting the course reported that “their knowledge of environmental issues greatly increased within the course” (p. 11). The remaining two groups, those with a moderate or low interest and commitment to the environment when entering the course, also felt their knowledge had increased but many
in each group also “felt that conservation of natural resources had become very important to them” (p. 11).

Research on Sustainability in Educational Settings

Much of the research currently found regarding sustainability in educational settings is at the collegiate level. Many colleges have conducted research on their campuses regarding sustainability, global climate change, and environmental awareness. This section summarizes some of these research studies.

In September and October of 2001, 200 college students from the University of South Carolina and Clemson were surveyed on issues regarding awareness of environmental issues and terms, among other issues (Pendarvis, 2002). According to the survey results, 48.5% of the respondents were passively concerned and 11.5% were actively concerned about the development of “green” energy, while 60% were passively concerned and 28.5% were actively concerned about dwindling natural resources. When asked about their recycling habits, 61% frequently recycled paper, plastics, cans, etc; 85.5% turn off the lights when they leave a room, 17% frequently, by choice, rely on public transportation instead of a personal vehicle; 47.5% frequently make an effort to conserve water; and 16% frequently use their own bag or carry what they bought instead of using a bag from the store. When asked what comes to mind when hearing the term sustainability, 32% didn’t know; 15.5% thought of conservation, recycling, and preserving; and 13% thought of natural resources and environment relations. This survey showed a wide range of results and attitudes from the students surveyed. However, it is important to remember that this study only encompassed a total of 200 students from two different colleges.
In a survey of 200 students from Macalester College (St. Paul, MN), respondents were asked to answer questions regarding environmental mindsets and specific environmental issues (Neuschler, 2002). Students felt that the two environmental issues most needing to be addressed on campus were paper and energy usage, and almost 120 respondents indicated they would reduce their paper use in campus computer labs if they had to pay for printing over a certain number of pages. Over 160 respondents felt the campus should purchase a certain amount of electricity from renewable sources, and about 150 would be willing to pay more for this electricity. The survey concluded that “students seem to be relatively well informed about environmental issues” however, “they do not appear as top campus issues” (Conclusions section, ¶ 1). Again, it should be noted that only 200 participants were included in this survey.

In the spring of 2004, 533 students at Colby College in Waterville, ME, participated in an online survey regarding environmental attitudes (Green Colby, 2008). Sixty-six percent of respondents felt that environmental practices were not well observed at Colby College, while 64% felt that their environmental awareness had increased since enrolling at the college. Seventy-five percent of the respondents indicated that they recycled, with only 46% feeling that the college’s recycling program was effective.

Construction Education

Literature in construction education was reviewed in the areas of technology education in the United States, relative national research, research in the state of New York, and relative descriptive reports. Given the role it plays in the treatment of this research study, the section begins with a discussion of LEED.
Leadership in Energy and Environmental Design (LEED)

The LEED Green Building Rating System “encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood tools and performance criteria” (United States Green Building Council [USGBC], 2008b, what is LEED section, ¶ 1). LEED was developed by the USGBC as a step towards accomplishing its mission of transforming “the way buildings and communities are designed, built and operated, enabling an environmentally and socially responsible, healthy, and prosperous environment that improves the quality of life” (USGBC, 2008a, USGBC’s Mission Statement section, ¶ 1). LEED currently has rating systems in place for new construction, existing buildings: operation and maintenance, commercial interiors, core and shell, schools, retail, healthcare, homes, and neighborhood developments (USGBC, 2008b). LEED is being adopted by state governments, LEED initiatives are in federal agencies, and LEED projects are in progress in 41 other countries (USGBC, 2008b). Starting in 2001, building professionals were given the opportunity to obtain LEED Professional Accreditation through which they have demonstrated an understanding of green building principles and the LEED rating system (USGBC, 2008c). Since 2001, 43,000 people have obtained the accreditation, giving these professionals the ability to manage the LEED certification process (USGBC, 2008c).

Construction Technology Education in the United States

Different states have varying curriculums and guides regarding construction at the secondary level. In Indiana, there is a course titled “Construction Systems” and includes units on designing structures, building construction, and community planning (Fitzgerald,
The course is meant to allow students to “explore the application of tools, materials, and energy in designing, producing, using, and assessing that construction of structures” (Fitzgerald, 2008, p. 2).

The Louisiana Department of Education (2003) lists a course titled “Construction Technology.” This course is meant to cover “all areas of the construction industry from planning to the completion of light, heavy, industrial, and civil construction and the various careers associated with each area” with units covering construction materials, tools and equipment, enterprises, and projects (Louisiana Department of Education, 2003, ¶ 1).

The North Dakota (ND) Department of Career and Technical Education (2008) suggests level one and level two construction technology courses, with the level one course being a prerequisite to the level two course. “Construction Technology I” is meant to provide an “orientation to the construction trade” (¶ 1) while “Construction Technology II” continues “with advanced training in Floor, Wall, and Roof Systems” (¶ 2). The courses showcased above show the similarities and differences among different states’ construction curriculum.

*National Research and Descriptive Reports Regarding Construction Technology Education*

Some research on the national level was found regarding construction technology in the fields of technology education and vocational education. ProQuest Dissertations and Theses (PQDT), ERIC, Virginia Tech’s Library and Archives, and the Internet were searched. Dissertations and theses found through PQDT regarding construction
technology education were found to be out of date or not related to sustainability within construction technology education.

The *International Journal of Construction Education and Research* (n.d.) replaces *the Journal of Construction Education* and publishes “scholarly work in the areas of construction education and construction research” mostly regarding post secondary education (¶2). An article was published in their journal in 2007 regarding sustainable construction curriculum (Tinker & Burt, 2004). Benefits of sustainable construction were presented, including improved profits, improved corporate image, and increased employee productivity (Tinker & Burt, 2004). Tinker and Burt (2004) relay that “there is both a moral and financial responsibility to educate future constructors in sustainable issues” (p. 31).

One research study conducted in Nebraska determined that seventh grade students who learned about construction technology in a contemporary laboratory setting with modern equipment in conjunction with traditional work benches and industrial machinery show an achievement gain of 19.9% between a pre test and a post test (Rogers, 2000). This was in comparison to a modular lab setting and a traditional lab setting where students showed no significant gain (Rogers, 2000). Overall, within the scope of the study, Rogers (2000) determined that contemporary laboratory environments provided the greatest overall achievement gain when compared to traditional and modular laboratory environments. This is relevant to this research study since the learning cycle used calls for use of a contemporary laboratory environment, one with modern technologies such as computer numerical control (CNC) equipment and computer-aided
drafting (CAD) equipment as well as hand tools and wood processing machinery (ITEA, 2006).

Research in New York Regarding Construction Technology Education

No research could be found regarding construction technology education in the fields of technology education and vocational education in the state of New York. ProQuest Dissertations and Theses (PQDT), ERIC, and Virginia Tech’s Library and Archives were searched, with no research being located. A comprehensive Internet search was completed as well, again with no research being located. In general, there seems to be a lack of published research in the above mentioned sources regarding the fields of technology education and vocational education in New York State.

The New York State Department of Education (NYSED) (n.d.) lists three syllabi related to construction: “Construction Systems,” “Construction Engineering / Management,” and “Residential Structures.” The course outline for the “Construction Systems” is modeled after a system and its parts. Therefore, it includes sections regarding the command input including expected impacts, people, materials, superstructures, completed projects, and outputs including environmental impacts. In relation to sustainability, the course outline does look at expected environmental impacts, raw material sources, energy, and output environmental impacts. The course outline for “Construction Engineering/Management” includes modules on management, engineering, types of construction, the construction process, and impacts of construction. Regarding sustainability, the course outline only has one section regarding the impacts of construction including how it affects our lives and construction in the future. “Residential Structures” includes sections on planning, tools and equipment, safety, framing, and
effects. Regarding sustainability, the “Residential Structures” syllabus has sections regarding material availability and procurement, innovative techniques in all areas of construction, energy management outputs, and environmental impacts.

**Examples of Sustainability Instruction in Construction Education**

Some examples of sustainability in construction education, mostly at the post-secondary level, do exist. One example of sustainability instruction is the learning cycle “Seeing Green” developed by the ITEA (2006) as part of a Construction Technologies curriculum that is being utilized for this research study. Within the learning cycle, students are asked to research and build examples of optimum value engineering where less materials are used to construct a building that is environmentally sound (ITEA, 2006). Students are also asked to research the qualifications for LEED certification (ITEA, 2006), with LEED being discussed further later in this chapter.

The British Columbia School of Construction (n.d.) and the environment uses a Sustainability Framework in order to “inform all educational programs, research and operational activities” (¶ 1). Six themes are used to guide the framework: protect and strengthen assets, balance use and renewal of resources, account for all costs and benefits, reduce waste and eliminate toxics, ensure safety and access to services, and support opportunities for improvement and enjoyment (British Columbia Institute of Technology, n.d.). These six themes are meant to showcase the “inter-relatedness of ecological, social and economic interest needed to meet the challenge of sustainability” (British Columbia Institute of Technology, n.d., ¶ 3).

At the UC Berkeley Extension, there is a class in the subject area of construction management titled “Sustainable Construction Management and Field Practices” (Regents
of the University of California, n.d.). There are also many specialized programs of study related to sustainability that incorporate approximately 30 – 90 hours of coursework per study including *Solar Energy and Green Building and Sustainable Design* (Regents of the University of California, n.d.). San Diego State University (2008) offers a professional certificate in *Green Building Construction* that is for “those interested in the implementation of sustainable building tools strategies” (¶ 1). The certificate program includes courses on green building and LEED.

Goodheart-Willcox Publisher produces a textbook for grade levels nine through fourteen titled *Modern Carpentry, 11th Edition* (Goodheart-Willcox Co., Inc., 2008). This textbook includes a chapter on passive solar construction, though no direct chapter on sustainable construction is present.

*Descriptive Reports on Sustainability Instruction in Construction Education*

Though few in number, there are descriptive reports regarding sustainability instruction in construction education at the collegiate level. According to Kibert and Ries (2009), the University of Florida has been incorporating sustainability instruction in to its construction program for almost fifteen years and has resulted in their “students being well versed in the issues of green building, green building standards, low impact construction methods, building health, construction waste reduction, recycling of construction and demolition debris” (p. 6). They feel that this has resulted in the construction industry in the state “being rapidly transformed by these graduates with the added benefit of positioning their companies to be partners in green building projects because they are readily qualified to become LEED Accredited Professionals” (p. 5).
In another example, a professor at the University of California, Chico, was approached by students in the undergraduate program who were interested in the LEED-AP certification process (Brown, 2009, p. 2). After forming a special topics course, the students and professor began to meet for two hours a week and at the end the professor as well as nine students took the LEED-AP exam with only two passing (Brown, 2009, p. 3). Brown (2009) then set out to develop an elective course titled “Green Building Practices and LEED Certification” with the main focus being “to introduce students to green building technologies and sustainable building design alternatives” through the use of the LEED New Construction (NC) rating system and case studies and has resulted in more than sixty students passing the LEED-AP exam (p. 3).

As we look at the research and descriptive reports covered, it is clear that there is a lack in the field of research regarding sustainability education, particularly in its effects on students’ reported attitudes and behaviors as well as in the field of technology education, and more specifically construction education at the secondary level. However, also through the research and literature reviewed, it is clear that there is curriculum regarding sustainability already developed as well as some instruments that have already been used in an attempt to measure students’ knowledge, attitudes, and behaviors relative to sustainability. Also, it can be seen that there are educational standards that directly and indirectly address sustainability in technology education and other subject areas.
Chapter 3: Methods

The following section outlines the methodology for the research study regarding the impact of a sustainable design learning cycle on high school students’ reported attitudes, reported behaviors, and knowledge regarding sustainability. This section contains information on the research design and context, participants and sampling method, instruments, treatment, procedures, treatment administration, and data analysis methods.

*Research Approach, Design, and Context*

A quasi-experimental method, employing a pre and post test within group design was employed for quantitative data collection regarding students’ reported attitudes and reported behaviors. Entries in to a logbook served as quantitative data as well, with a goal of assessing the knowledge gained by the students in regards to the domains of sustainability and the objectives of the learning cycle.

The context of the study was a single high school residential construction course. This course was chosen for its relation to the learning cycle to be used as the treatment and is to be considered a convenience sample. It is important to note that this course was considered a technology education elective and was not required for graduation. Students enrolled in the course either chose to enroll in this course or were assigned to the course by a guidance counselor. The high school was located within a school district in rural,
upstate New York. Approximately 400 students were enrolled in grades prekindergarten through twelve, with all grade levels being housed in the same building. The school district was located in a low income area, with approximately 20% of students qualifying for free or reduced lunch. The school district was known in the area for its small class sizes, resulting in a low student to teacher ratio.

Students in the school attended classes for six and a half hours a day, with forty minute classes that meet every day or every other day with an extra forty minute period provided at the end of the day for extra help with teachers as needed. The district employed one technology education teacher who was responsible for all technology education instruction for elementary, middle, and high school students. The school’s sole, year-long residential construction course utilized within this study met the first period of every day that school was in session and was open to students in grades nine through twelve. The goal of this course was for each student to demonstrate introductory knowledge and skills related to residential construction, including safety practices, footing and foundation techniques, framing methods, and finishing techniques. The student enrollment in each high school technology education elective course varies by school year, usually falling between ten and fifteen students. There were no prerequisite courses for this course and the learning cycle came near the end of the year-long course. The study took place during the 2009 – 2010 school year, starting at approximately week 31 of a 40 week school year. Students had no prior instruction in the course on sustainability as the course did not follow any of the suggested construction related syllabi from NYSED as reviewed earlier in this thesis.
The technology education facility was divided into two sections, a classroom and a laboratory, with windowed walls separating the two. Students had access to computers in the classroom area and woodworking, model building, metalworking, and plastic forming equipment in the laboratory area. The technology education facility and program were well supported by the administration, school board, and community.

Participants and Sampling Method

Students were previously enrolled in the course, and were therefore not selected or assigned for the purposes of this study. Students in the course covered various age and grade levels, and also came from varying backgrounds in terms of science courses. The subjects of this study were those eleven students electing to participate from a class of seventeen high school students, varying in grade level with two subjects in the ninth grade, five subjects in the tenth grade, and four subjects in the eleventh grade. Five subjects were sixteen years of age and six subjects were seventeen years of age. Six of the subjects were male and five of the subjects were female. All students in this course had received the New York State mandated forty weeks of technology education at the middle school level, and six of the subjects had taken at least one other high school technology education elective in previous school years. It is unknown whether the subjects received any instruction related to sustainability in their middle school level technology education courses as the instructor is no longer employed by the district and no records exist with the information. One of the subjects in the study had previously taken an energy course offered at the school, which had a strong emphasis on sustainability as related to energy use.
All students in the course were on track to complete a local or Regents diploma at the time of the study. Five subjects in this study were enrolled in an Earth Science course at the time of the study, and six subjects had already completed an Earth Science course. One subject was enrolled in an elective science course, Environmental Science/Ecology. Students in this course had received no previous instruction regarding sustainability within the course.

**Instruments**

Within this study, two different instruments were used to gather data. An identical twenty question pre and post test titled Student Survey Measuring Sustainability Attitudes and Behaviors was used to gather information regarding students’ reported attitudes and reported behaviors. This test was produced by the researcher and another expert by choosing items from surveys used in previous studies regarding sustainability attitudes and behaviors. These items were chosen for their relation to the domains of sustainability. Also, students in this study completed logbook entries which used to determine students’ knowledge gains relative to the domains of sustainability and the learning cycle objectives. One of the logbook entries used was previously determined by the learning cycle used while others were determined by the researcher.

*Attitudinal and Behavioral Instrument*

In order to develop the instrument for this study, several instruments that were previously used in similar studies were reviewed. Michigan State University conducted an environmental survey of 1,554 freshmen students on the campus in the fall of 2000 and the spring of 2003 (Mertig, 2003). This survey used a Likert scale for many items measuring students’ attitudes, and similar interval scales for most other items (Mertig,
2003). This survey also tested students’ knowledge of current environmental issues and asked for background information such as their major, parents’ highest level of education, and gender and also gave students a chance to express comments (Mertig, 2003). Another survey mentioned previously, the survey administered to students at Clemson and the University of South Carolina, was also utilized (Pendarvis, 2002). Pendarvis (2002) also used interval scales of measurement for many items, but students were also asked many items regarding their current level of activity in regards to environmental activities. The instrument used in this research study was compiled from these instruments.

In order to assess reported changes in behavior and attitude, students in this course were administered a pre and post test with the same items in the same order for the pre and post test, as seen in Appendix A and titled Student Survey Measuring Sustainability Attitudes and Behaviors in order to analyze the change in their reported attitudes regarding sustainability. The items on the instrument were chosen for their correspondence to one or more of the four domains of sustainability (ecological, social, economic, and political, institutional, and cultural), further explained in the literature review section. Since the instruments referenced were utilized in previous studies, they appear to have face validity.

Validation of the formed instrument occurred through the categorization of each item chosen according to the four domains of sustainability, as well as through review of the instrument by professionals with expertise in related fields. A currently employed science teacher in the school district, who had received professional instruction related to sustainability, analyzed each item in the two above referenced surveys and categorized them according to the four domains of sustainability. This initial reviewer then met and
discussed his categorical choices with the researcher, who had done the same. Following this, the initial reviewer and the researcher worked individually to choose items addressing the domains of sustainability with a goal of choosing twenty items as evenly distributed as possible across the four domains of sustainability. The initial reviewer and the researcher then met again in order to decide on the final twenty items for the test. A final review of the test was then conducted by a high school English teacher in order to assure the test used terms that could be easily understood by high school students. Small wording changes were suggested by the English teacher to be sure the terms used in the items were at the subjects’ level and able to be fully understood, which were then made by the researcher.

Following formation of the instrument and the review by the English teacher, three professionals in related fields reviewed the test for validation purposes. One professional was an environmental technician who is in charge of safety training, school group tours, and monitoring of an area landfill. The next professional was a college instructor at a New York State college who teaches courses in an undergraduate technology education degree program, with a primary focus on courses in technology education and energy, as well as organizing and running a summer energy institute for teachers. The third professional was another college professor in a technology department at a college in another state who is also LEED-AP certified. All three professionals were sent a brief synopsis of the purpose of the research study as well as three documents: the draft instrument to be reviewed, a table showing the domains of sustainability that each item was chosen to represent (refer to Appendix B), and a document giving further explanation of the domains of sustainability. One professional felt that the domains were
adequate for the study and that the instrument covered the domains well. This
professional’s only concern was how the various types of items on the instrument would
be evaluated in the end. Another professional felt that item numbers four, fifteen, and
seventeen on the instrument should be reworded and these items were per their
suggestion. However, the same professional felt that the test would accomplish the goals
of the research study and sufficiently gauge how the instruction affected students’
reported attitudes and reported behaviors. The third and final professional noted that the
economic domain could be inaccurately interpreted as financial if not adequately
explained and commented that financial could also be a domain. However, given the
provided definition for the economic domain, the third professional felt that the items on
the test adequately covered the domains of sustainability.

One example of an instrument item utilized an interval scale of measurement,
asking subjects to choose either *strongly agree, tend to agree, neither agree or disagree,
tend to disagree, or strongly disagree* when asked, “How much do you agree with the
following statement: The fact that natural resources are diminishing is a problem.” This
item related to the objectives of the learning cycle and also to the ecological domain of
sustainability. Another instrument item asked, “How much do you agree with the
following statement: The development of “green” energy is important.” This item related
to the economic domain of sustainability.

Refer to Appendix B for a complete categorization of each items’ relation to the
four domains of sustainability as selected by the initial reviewer and the researcher
following discussion and as validated by the final three reviewers. Some items were
determined to be related to more than one domain, with ten items in the ecological
domain, ten items in the social domain, eight items in the economic domain, and twelve items in the political, institutional, and cultural domain. Though not equally distributed, it was determined by the initial and final reviewers that the items were sufficiently balanced.

*Logbook Data and Coding*

In order to assess subjects’ conceptualization of the domains of sustainability and the objectives of the learning unit, subjects completed logbook entries as part of the treatment. Each subject made four entries in their logbook at predetermined times within the learning cycle, which were dated. One of the four logbook entry topics was previously determined within the learning cycle and related to the current task being performed while the remaining three logbook entries and topics were determined by the researcher.

The first logbook entry was determined by the “Seeing Green” learning cycle (ITEA, 2006). It asked subjects to answer the following three questions, relative to the research they had just completed:

1. What are some of the ways to earn LEED credits that seem fairly easy to accomplish?

2. What are some of the ways to earn LEED credits that seem difficult to accomplish?

3. In general, what is the process to obtain LEED certification for a building (ITEA, 2006, p. 87)?
The second logbook entry was created by the researcher and was modeled after the first logbook entry. Following research regarding optimum value engineering (OVE), the subjects were asked to answer the following questions:

1. What are some of the methods of OVE that seem fairly easy to accomplish?

2. What are some of the methods of OVE that seem difficult to accomplish?

3. In general, what are the OVE techniques that you think could be incorporated into residential construction?

The third and fourth logbook entries were also created by the researcher, with logbook entry three being related to the activity that was just completed in the learning cycle and logbook entry four meant to incorporate all that was covered in the learning cycle. Logbook entry three asked students to answer the question, “How could your school be modified to better meet the LEED requirements for school buildings?” Logbook entry four asked students to record their thoughts on living in a home that had been built using sustainable practices such as those discussed in the learning cycle.

A matrix, as presented in Appendix C, was used to categorize each sentence made in each logbook entry, with the domains of sustainability on one axis and the objectives of the learning unit (Appendix D) on the other axis. This allowed the coders to code each sentence according to the domains of sustainability and learning objectives.

**Treatment**

The treatment for this research study was the learning cycle titled “Seeing Green” (ITEA, 2006). It was developed by the ITEA (2006) as part of the *Construction Technologies* learning unit curriculum in an attempt “to address the critical need for
upper high school technology education curriculum” and was implemented by the researcher (p. v). The objectives for the learning cycle included identifying key elements of green building, describing the process and requirements of Leadership in Energy and Environmental Design – New Construction (LEED-NC) certification, and designing and modeling buildings that utilize optimal value engineering (Appendix D). In this learning cycle, an objective was for students to “learn how current green building trends are changing the way residential buildings are being designed and built” (ITEA, 2006, p. 84). Students also modeled different green building techniques (ITEA, 2006).

The learning cycle was divided in to four phases: exploration, reflection, engagement, and expansion during an approximate three week time frame (ITEA, 2006). The exploration stage asked students to “research specific sections of LEED-NC” (p.84). During the exploration phase, students were interacting with materials and equipment while collecting, recording and analyzing data. Students were also investigating concepts while designing solutions. The instructor’s role during the exploration phase was to ask questions of the students and to oversee safety and skills instruction.

Following completion of the exploration stage, students then entered the reflection stage where they exhibited “the knowledge and experience they have acquired” by answering questions regarding LEED-NC (ITEA, 2006, p. 89). Throughout the course of the reflection phase, students were participating in discussions, answering questions in the Inventor’s Logbook, comparing team data, and forming generalizations. During the reflection phase, the instructor was required to lead class discussions, correcting misconceptions, ask questions of the students, and facilitate class data sets.
For the engagement stage, students “were to research carefully to obtain useful information” before selecting an optimum value engineering or advanced wall framing technique to replicate as a scale model (ITEA, 2006, p. 90). According to ToolBase Services (2001), optimum value engineering and advanced wall framing techniques are construction techniques that “use engineering principles to minimize material usage while meeting model building code structural performance requirements” (¶2). During the engagement stage, students were applying concepts, solving problems, and designing and building solutions. The instructor’s role during the engagement stage was to correct any misconceptions and keep students on task while assuring safety practices.

The expansion stage is not a required part of the “Seeing Green” learning cycle, however for the purposes of this study, students were asked to choose one of the three expansion activities to complete (ITEA, 2006). Choices include researching the current status of the LEED-Homes program, researching green building initiatives that are not part of the United States Green Building Council, and conducting an informal LEED assessment of their home or school. During the expansion stage, students were responsible for researching, extending concepts in to different contexts, and journaling in their logbooks. While in the expansion stage, the instructor was responsible for questioning students to be sure connections are being made and providing appropriate resources.

Formative learning assessment strategies included asking students questions, observing students while they were working, and review of the students’ logbooks. Resources needed for this learning cycle included photocopies of the student guide and
student logbooks, computers with Internet access, drawing paper, architectural scales, model pins, glue, utility knives, and balsa or basswood.

**Procedures**

Following instrument validation, permission was sought and granted through the Ball State University Institutional Review Board following submission of a human subjects’ research protocol. Permission from school administration was obtained in order to conduct this research. Permission from ITEA was obtained for use of their learning cycle materials in this study. Guardian and student permission was granted during the spring of the 2009 school year through an informed consent form modeled after the Ball State University Institutional Review Board’s form, as seen in Appendix E. The forms were distributed and explained to the students by the researcher approximately a week prior to the start of the treatment. Students then returned the signed forms to another teacher in the building. The informed consent forms were given to the researcher upon submission of all final grades. The instructor did not know which students elected to participate until final course grades were submitted due to the collection of the informed consent forms by a third party. However, the instructor was aware of the number of subjects. All students in the course experienced the same treatment regardless of their participation.

**Treatment Administration**

This treatment was administered during the spring of 2009 during course instructional time, covering approximately a three week period as suggested by the curriculum (ITEA, 2006). The researcher, who was also the instructor of this course, administered the pre test, treatment, and post test. The pre test was administered prior to
any instruction for the learning cycle and the post test was administered immediately following the completion of the learning cycle. The student logbook entries were collected immediately following the completion of the learning cycle. Copies of the logbooks were made, and the originals were returned to students.

Data Analysis Methods

On both the pre and post tests, none of the Likert-type items were left unanswered or with invalid answers, resulting in no need for data cleaning. Therefore, there was no percentage of questions not answered to report. The data was keyed in to a spreadsheet. In order to check for transfer errors, the data was reviewed by the researcher multiple times following the original entry. Data was securely stored on a password protected, private computer hard drive and a password protected flash drive for backup.

A Wilcoxon Signed Ranks Test was utilized with a bidirectional level of significance for statistical analysis of $\alpha = 0.05$ to compare pre test and post test scores individually for eighteen of twenty instrument items. The Wilcoxon Signed Ranks Test was chosen after discussion with an expert in the field of statistics (J.A. Jones, September 9, 2009). The Wilcoxon Signed Ranks Test is a test used for data that is not normally distributed (McDonald, 2009). It is used where “one of the nominal variables has only two values, such as a ‘before’ and ‘after,’ and the other nominal variable often represents individuals” (McDonald, 2009). An Excel spreadsheet downloaded from an Internet website was utilized to perform the mathematical analysis for these questions (McDonald, 2009). This Internet tool was also chosen after discussion with the same statistics expert (J.A. Jones, September 17, 2009).
The student logbook entries were analyzed by two trained coders using a matrix as presented in Appendix C, allowing for analysis with regards to the learning cycle objectives and four domains of sustainability. The two coders individually coded each sentence in each entry of the logbooks, and then met to discuss their results. Each sentence related to one of the four domains from each log book entry was analyzed and marked on the matrix in an attempt to determine how many sentences related to each domain and learning objective, thereby showing how subjects conceptualized the domains of sustainability and the learning cycle objectives. The coders agreed on most of the logbook entry sentences at the onset, and after discussion, agreed on the coding of all logbook entry sentences.
Chapter 4: Results and Discussion

Following administration of the pre test, treatment, and post test, results have been statistically analyzed in an attempt to determine if the “Seeing Green” learning cycle resulted in a change in students reported attitudes and reported behaviors. Logbook entries were then coded to determine if students gained knowledge related to the domains of sustainability and the learning cycle objectives.

*Attitudinal and Behavioral Instrument Results*

Eighteen of the twenty items on the pre and post test were analyzed using the Wilcoxon Signed Ranks Test with the results presented in Table 1. The items on the pre and post test fell into two distinct categories: items using a Likert-type scale and items that asked subjects to record a number. Descriptive analyses of the fourteen Likert-like items indicated a median of 4 and an interquartile range of 2 on the pre test; post test results indicated a median of 4 and an interquartile range of 2. For the items requiring students to enter a number, the median was found to be 1 and the interquartile range was found to be 3 on the pre test. The median for the same items on the post test was found to be 1 and the interquartile range 2. For all eighteen of the items analyzed, there were no statistically significant pre to post test changes detected, indicating that there was no change in subjects’ reported attitudes or reported behaviors regarding sustainability as a result of the instruction on sustainability.
Table 1

*Summary of Wilcoxon Signed Ranks Test Scores and Medians for Pre and Post Test Data*

<table>
<thead>
<tr>
<th>Question Number</th>
<th>Question</th>
<th>df</th>
<th>Pretest Medians</th>
<th>IQR</th>
<th>Posttest Medians</th>
<th>IQR</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>How concerned are you personally about environmental problems?</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>Overall, how concerned is the family you live with about environmental problems?</td>
<td>9</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>How much do you agree with the following statement: The fact that natural resources are diminishing is a problem.</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>10.5</td>
</tr>
<tr>
<td>5</td>
<td>How much do you agree with the</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>
following statement:

The development of
“green” energy is
important.

| 6 | How much do you agree with the following statement: | 5 | 4 | 1 | 5 | 1 | 6 |

| 7 | Within the past year, about how many different projects have you participated in related to environmental / sustainability issues (through school organizations, class projects, volunteer work, etc.)? | 7 | 1 | 1 | 1 | 1 | 3 |

| 8 | Within the past year, 13.5 | 7 | 1 | 2 | 1 | 7 | 13.5 |
about how often have you chosen to read publications or watch TV programs that focus on environmental issues?

<table>
<thead>
<tr>
<th></th>
<th>Within the past year,</th>
<th>9</th>
<th>2</th>
<th>3</th>
<th>1</th>
<th>2</th>
<th>13</th>
</tr>
</thead>
</table>

about how often have you encouraged people involved in some kind of environmentally destructive behavior to stop that activity?

|   | Within the past year, | 8  | 2  | 5  | 2  | 2  | 15 |

about how often have you encouraged others to take an action on behalf of the environment?

|   | Within the past year, | 5  | 4  | 2  | 4  | 1  | 0  |
about how often have you made an effort to turn off the lights when you are the last to leave a room?

<table>
<thead>
<tr>
<th>Question</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within the past year, about how often have you made an effort to use less water when brushing your teeth or bathing?</td>
<td>2.5</td>
</tr>
<tr>
<td>How often do you recycle paper, plastics, cans, etc.?</td>
<td>2.5</td>
</tr>
<tr>
<td>How often, by choice, do you keep thermostats set at energy conservation levels and/or limit your use of air conditioning?</td>
<td>15.5</td>
</tr>
<tr>
<td>When available, how</td>
<td>9</td>
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</tbody>
</table>
often do you make an
effort to purchase
recycled products or
products packaged in
recycled materials?

16

How often, by 7 3 2 2 3 7
choice, do you
carpool instead of
driving alone?

17

How appropriate do 3 5 1 5 0 3
you feel it is for your
school to promote
recycling activities?

18

How appropriate do 6 5 1 5 1 10.5
you feel it is for your
school to promote the
need for conservation
of natural resources?

19

How willing are you 7 3 1 4 1 12
to do more on behalf
of the environment?

Note. For the Wilcoxon Signed Ranks Test scores, all p values were >.05.
Item three of the pre and post test asked subjects to record what came to mind when they heard the word sustainability. The results can be seen in Table 2. Considering the definition of sustainability presented in the definition of terms section, it appears that most (approximately 73%) subjects did gain knowledge of the term sustainability and green building in the course of the treatment. Examples would be student D who had no response on the pre test but responded with “conservation of energy” on the post test and student H who responded on the post test with “when the world puts out as much resources as the things that are on it use up.” When looking at the subjects’ answers, 54% of subjects had no response on the pre test and only 27% of subjects had no response on the post test, all of whom had no response on the pre test as well. All eight responses given on the post test show an awareness-level knowledge of sustainability or green building’s relation to sustainability.
Table 2

*Summary of Subjects’ Answers to Question Three Regarding What Comes to Mind When Hearing the Term Sustainability*

<table>
<thead>
<tr>
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<th>Pre Test</th>
<th>Post Test</th>
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<tr>
<td>Student A</td>
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</tr>
<tr>
<td>Student B</td>
<td>No answer</td>
<td>No answer</td>
</tr>
<tr>
<td>Student C</td>
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<td>No answer</td>
</tr>
<tr>
<td>Student D</td>
<td>No answer</td>
<td>Conservation of energy</td>
</tr>
<tr>
<td>Student E</td>
<td>No answer</td>
<td>Reuse of materials; green buildings</td>
</tr>
<tr>
<td>Student F</td>
<td>How long we can go using up resources</td>
<td>The ability to live without depleting much resources</td>
</tr>
<tr>
<td>Student G</td>
<td>Something that stays at a good level</td>
<td>When the environment can be sustainable – it can’t be overused or not used at all</td>
</tr>
<tr>
<td>Student H</td>
<td>The ability to have control over what goes in and out of our hands</td>
<td>When the world puts out as much resources as the things that are on it use up</td>
</tr>
<tr>
<td>Student I</td>
<td>Keeping something at a point where it can last depending on the environment</td>
<td>Stability that can stay at an even point or average point</td>
</tr>
<tr>
<td>Student J</td>
<td>Making more natural resources</td>
<td>Ability to use / re-useable</td>
</tr>
<tr>
<td>Student K</td>
<td>No answer</td>
<td>Reuse of materials; green building</td>
</tr>
</tbody>
</table>
Item twenty asked subjects, “Which would best explain your personal motivation for becoming involved in sustainability type behaviors?” No statistical analysis was conducted on the results of this item, but the results from the pre and post test can be seen in Figure 1. Between the pre and post test, there was an increase for choice a, “You genuinely believe it would make the world a better place.” For choice b, “It is personally rewarding,” there was a decrease between the pre and post test. There was a decrease between the pre and post test for choice c, “You are told or expected to.” No subjects picked choice d, “For personal or economic benefit” in the pre test, but one subject did in the post test. Again, no subjects chose choice e, “Other” in the pre test, but two subjects did in the post test. Choice f, “None” decreased between the pre and post tests.

![Figure 1. Results for Item 20: “Which would best explain your personal motivation for becoming involved in sustainability type behaviors?”](image-url)
Logbook Results

Subjects were asked to complete logbook entries at four different points. As reported above, logbooks were coded according to statements related to the four domains of sustainability and the three learning objectives of the learning cycle.

Logbook Entry One asked subjects to answer three questions following completion of a LEED presentation regarding LEED credits that seem fairly easy to accomplish, LEED credits that seem difficult to accomplish, and the process to obtain LEED certification for a building. All eleven of the subjects involved in the study completed logbook entry one. The coders determined that each subject had the same number of statements for each domain and objective. Given the limitations of the questions, it is rational that the statements by the subjects would all categorize in to the same domains and objectives. Many of the statements related to the learning objective about LEED certifications (46% of total statements), while many others related to the learning objective regarding green building (44% of total statements) and the ecological domain (44% of the total statements). Within the domains of sustainability, most of the statements related to the economic domain (44% of the total statements). Given the prompts of the logbook entry, it is not unexpected to see that no statements were made related to the optimum value engineering objective or the social domain. The results of the coding of logbook entry one can be seen in Table 3, with each unit in the table representing one sentence and each sentence being cross classified in a domain and a learning objective.
Table 3

Number of Statements Relating to Domains/Objective in Logbook Entry One

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Logbook Entry Two asked subjects to answer questions related to optimum value engineering (OVE). These questions asked subjects to identify what methods of OVE appeared easy to accomplish, what methods of OVE seemed difficult to accomplish, and
what OVE techniques they felt could be accomplished in residential construction. Only eight out of the eleven subjects completed logbook entry two. As in the results of logbook entry one, all of the subjects made the same number of statements for each domain and objective. Again, this is a result of the limitations placed by the specificity of the questions subjects were asked to respond to. Half of the statements in these logbook entries related to the OVE objectives (50% of total statements) and green building objectives (50% of total statements). Within the domains of sustainability, the statements were equally split between their relation to the ecological, social, and economic domains (33% of total statements for each domain). Again, as expected due to the scope of the logbook entry, no statements were made related to the political, institutional, and cultural domain or to the LEED certification domain. The results from the logbook entry coding can be seen in Table 4.
Logbook Entry Three asked subjects to comment on how their school could be modified to better meet LEED requirements for school buildings. Nine of the eleven subjects responded to logbook entry three. Unlike logbook entries one and two, subjects

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had varying amounts of statements in their entries. This is likely a result of the lack of specificity in what the subjects were asked to respond to. In logbook entries one and two, they were given specific questions to answer, where as in logbook entry three they were asked to comment on a subject. The majority of statements fit in to the LEED certification objective (88% of total entries). Almost half of the statements related to the ecological domain (42% of total statements). No statements were made showing an understanding of the optimum value engineering objective. The full results of the statement coding can be seen in Table 5.
Table 5

Number of Statements Relating to Domains/Objective in Logbook Entry Three

<table>
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Logbook Entry Four, the final logbook entry, asked subjects their thoughts on living in a home that had been built using sustainable practices such as those discussed in this learning unit. Ten of the eleven subjects completed the fourth logbook entry. As in
logbook entry three, statements varied per subject. All of the statements showed an understanding of green building (100% of total statements). Many statements were found to be related to the ecological domain (46% of total statements) and also the economic domain (34% of total statements). No statements were made regarding the LEED certification or optimum value engineering objectives. The results of the coding of logbook entry four in the entirety can be seen in Table 6.
Table 6

Number of Statements Relating to Domains/Objective in Logbook Entry Four

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Chapter 5: Conclusions and Recommendations

The purpose of this quasi-experimental study was to determine if high school construction students’ reported attitudes and reported behaviors changed following the “Seeing Green” learning cycle. This study also set out to determine if the subjects gained knowledge relative to the learning cycle objectives and the four sustainability domains. This study employed a pre and post test within group design. Subjects were given a pre test to measure their reported attitudes and reported behaviors regarding sustainability. A treatment in the form of the “Seeing Green” learning cycle was then administered. During the course of the treatment, subjects also made entries in a logbook which then underwent a content analysis for connections to the domains of sustainability and learning objectives. At the end of the treatment, subjects took a post test identical to the pre test in order to compare changes in reported attitudes and reported behaviors.

There are many threats to the internal validity of this study that should be considered. The pre and post test used to measure changes in subjects’ attitudes and behaviors did employ items that covered all the domains of sustainability. However, some domains were covered by more items than others. Also the instrument was developed in part by the researcher, who also administered the instrument. The instrument did not specifically relate to construction, only to sustainability. Therefore, the
results may not be as pertinent as they could have been had either the treatment cover sustainability more broadly or the instrument relate strictly to sustainability within construction. The number of logbook entries as well as the narrow scopes of the logbook entries limited what could be determined from the logbook entries. The prompts used to guide the logbook entries did not equally represent all the domains of sustainability. Given that the researcher was one of the two coders of the logbook entries, this poses a threat to the inter-rater reliability.

The results of this study did depend on subjects answering the questions honestly on both the pre and post tests. Subjects may have already entered the course and study with attitudes or values regarding sustainability. Also, this study was held at the end of the school year when it is possible that subjects were feeling overwhelmed or distracted by final exams and projects in other courses, which may have affected the outcomes of this study. As a reminder, the results of this study cannot be generalized to the population given the fact that it was only tested on eleven students in one course within one school district.

Also, it is possible that the “Seeing Green” learning cycle was not a sufficient treatment regarding sustainability or that the learning cycle was not implemented at the level it needed to be in order to show change in subjects’ reported attitudes and behaviors. The subjects in this quasi-experimental research study only represented a small convenience sample. In terms of determining the knowledge gained specifically from the treatment, there was no measure of subjects’ pre-existing knowledge regarding sustainability. Therefore, when drawing conclusions from the logbook entry, it cannot
definitively be said the knowledge was gained from the learning cycle as subjects could have previously had this knowledge or gained knowledge from other sources.

Conclusions

Overall, it can be concluded that there is no statistical evidence that the implementation of the “Seeing Green” learning cycle in a secondary construction course influenced students’ reported attitudes and reported behaviors regarding sustainability. However, from the analysis of the logbook entries, it is evident that the subjects consistently gained knowledge relative to the economic and ecological domains of sustainability and the learning cycle objectives. However, varying degrees of understanding were developed with far less evidence that the “Seeing Green” learning cycle impacted relative understanding to the social and political, institutional, and cultural domains of sustainability.

Though the study results did not show statistical significance between subjects’ pre and post test answers, there were some interesting findings. When comparing some subjects’ pre and post tests, it was evident that some subjects had changed some of their attitudes and behaviors, especially in the areas of personally caring about environmental problems, turning off the lights when leaving a room, and feeling it is appropriate for their school to promote the need for conservation of natural resources.

The differences in the pre and post test answers to item three of the test do show an expanded understanding of the term of sustainability, as discussed above in the results section. Many (73%) subjects’ answers to item three on the post test show this, but with no statistical analysis performed on the responses, it is hard to definitively say if there
was an actual change or not. It is the researcher’s feeling that the results of this item do show a better understanding by the subjects of sustainability.

Overall, the second research question “As evidenced by student logbooks, did students gain knowledge in regards to the domains of sustainability and the objectives of the learning cycle?” was addressed through classification of the statements within each logbook entry by each subject. Subjects had a grasp of the concepts represented by the learning cycle objectives as evident through their statements. All statements subjects made relative to the domains of sustainability and also the learning cycle objectives were accurate. However, given the narrow scope of the logbook entries, it is not possible to say that subjects fully conceptualized the four domains of sustainability but only that they made accurate statements relative to the domains of sustainability. It is possible this is due to the narrowness of the curriculum and student activities in terms of sustainability as a whole. The logbook coding shows that subjects did gain knowledge regarding the domains of sustainability and the learning cycle objectives that they did not have prior to the treatment. However, it is possible that subjects may have had this information prior and not reported it or that subjects gained it in another way during the course of the treatment.

Recommendations

Statistically, the results of this research show that the treatment was ineffective in changing subjects reported attitudes or reported behaviors. Similarly, Peck (2009) reported that it was impossible to determine if changes in subjects’ behavior resulted in reduced energy use. On the other hand, just as Peck’s 2009 study and Martin’s 2003 study showed knowledge gains, the subjects’ did gain knowledge relative to sustainability.
as showcased in the logbook entries. Folio’s 2002 study also reported knowledge gains relative to environmental issues, but also resulted in some subjects feeling that conserving natural resources was very important to them, which this research study could not report as a result.

Given these results and their relation to other research, it is strongly recommended that the instrument continue to be developed in order to obtain a more valid and reliable instrument to measure students’ attitudes and behaviors related to sustainability. The researcher would recommend that pre and post test as well as the logbook entries and coding be done again with larger numbers of subjects and with a curriculum that has a more balanced focus on all domains of sustainability, especially the social domain and the political, institutional, and cultural domain. Also, it is important that the questions in the logbook entries not be so narrowly focused. It is recommended that future research be done with a larger number of subjects. It would also be recommended that a sustainability curriculum more balanced on the four domains be used in conjunction with the pre and post test at the post-secondary level to see if age and maturity might affect the results of the research.

Throughout the treatment, many subjects made comments and initiated discussions that showed the researcher the subjects were gaining knowledge and thinking about what they were being presented with. However, given the lack data to analyze these comments, the researcher concludes that possibly the methods of data collection were not sensitive enough to detect these small changes.

Overall, the researcher suggests that we not discount what may have been gained from this treatment. Though statistical significance was not shown, the researcher feels
the subjects did gain valuable knowledge and that some may change their attitudes and behaviors over time, partially as a result of this treatment. The effects of this treatment may not be seen immediately in some subjects, but combined with other sustainability information they are presented with over time, they may still change their attitudes and behaviors. The researcher feels this treatment was valuable and plans to repeat it again with future students, as the logbook entries did show that subjects understood the learning objectives of the treatment.
References


References Continued


Lane Community College Sustainability Program. (n.d.). Sustainability Vision Statement.

References Continued


References Continued


Peck, R. (2009). Study of the effects on student knowledge and perceptions of activities related to submetering the 6th grade wing of a middle school, to displaying the carbon footprint, and to efforts to reduce energy consumption and greenhouse gases. (ERIC Document Reproduction Service No. ED505893).
References Continued


References Continued


References Continued


References Continued


Appendix A

Pre and Post Student Survey Measuring Sustainability Attitudes and Behaviors

Name: ________________________           Date: _____________

**Pre and Post Student Survey Measuring Sustainability Attitudes and Behaviors**

1) How concerned are you personally about environmental problems?
   a. A great deal
   b. A fair amount
   c. Neutral
   d. A small amount
   e. Not at all

2) Overall, how concerned is the family you live with about environmental problems?
   a. A great deal
   b. A fair amount
   c. Neutral
   d. A small amount
   e. Not at all

3) When you hear the term “sustainability,” what comes to mind?

__________________________________________________________________
__________________________________________________________________

4) How much do you agree with the following statement: The fact that natural resources are diminishing is a problem.
   a. Strongly agree
   b. Tend to agree
   c. Neither agree or disagree
   d. Tend to disagree
   e. Strongly disagree

5) How much do you agree with the following statement: The development of “green” energy is important.
   a. Strongly agree
   b. Tend to agree
   c. Neither agree or disagree
   d. Tend to disagree
   e. Strongly disagree
6) How much do you agree with the following statement: The world’s population growth is a problem.
   a. Strongly agree
   b. Tend to agree
   c. Neither agree or disagree
   d. Tend to disagree
   e. Strongly disagree

7) Within the past year, about how many different projects have you participated in related to environmental / sustainability issues (through school organizations, class projects, volunteer work, etc.)? ______

8) Within the past year, about how often have you chosen to read publications or watch TV programs that focus on environmental issues? ______

9) Within the past year, about how often have you encouraged people involved in some kind of environmentally destructive behavior to stop that activity? ______

10) Within the past year, about how often have you encouraged others to take an action on behalf of the environment? ______

11) Within the past year, about how often have you made an effort to turn off the lights when you are the last to leave a room?
    a. Always
    b. Usually
    c. About half the time
    d. Seldom
    e. Never

12) Within the past year, about how often have you made an effort to use less water when brushing your teeth or bathing?
    a. Always
    b. Usually
    c. About half the time
    d. Seldom
    e. Never

13) How often do you recycle paper, plastics, cans, etc.?
    a. Always
    b. Usually
    c. About half the time
    d. Seldom
    e. Never
14) How often, by choice, do you keep thermostats set at energy conservation levels and/or limit your use of air conditioning?
   a. Always
   b. Usually
   c. About half the time
   d. Seldom
   e. Never

15) When available, how often do you make an effort to purchase recycled products or products packaged in recycled materials?
   a. Always
   b. Usually
   c. About half the time
   d. Seldom
   e. Never

16) How often, by choice, do you carpool instead of driving alone?
   a. Always
   b. Usually
   c. About half the time
   d. Seldom
   e. Never

17) How appropriate do you feel it is for your school to promote recycling activities?
   a. Completely appropriate
   b. Somewhat appropriate
   c. Neutral
   d. Not too appropriate
   e. Not appropriate at all

18) How appropriate do you feel it is for your school to promote the need for conservation of natural resources?
   a. Completely appropriate
   b. Somewhat appropriate
   c. Neutral
   d. Not too appropriate
   e. Not appropriate at all

19) How willing are you to do more on behalf of the environment?
   a. Entirely willing
   b. Very willing
   c. Somewhat willing
   d. Not very willing
   e. Not willing at all
20) Which would best explain your personal motivation for becoming involved in sustainability type behaviors?
   a. You genuinely believe it would make the world a better place.
   b. It is personally rewarding.
   c. You are told or expected to.
   d. For personal economic benefit
   e. Other
   f. No personal motivation for becoming involved in sustainability type behaviors
Appendix B

*Categorization of Survey Items as Related to Domains of Sustainability*

<table>
<thead>
<tr>
<th>Question</th>
<th>Ecological</th>
<th>Social</th>
<th>Economic</th>
<th>Political, Institutional, and Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) How concerned are you personally about environmental problems?</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2) Overall, how concerned is the family you live with about environmental problems?</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>3) When you hear the term “sustainability,” what comes to mind?</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
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<td>4) How much do you agree with the following statement: The fact that natural resources are diminishing is a problem.</td>
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<td></td>
<td></td>
<td></td>
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<td>5) How much do you agree with the following statement: The development of “green” energy is important.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Ecological</td>
<td>Social</td>
<td>Economic</td>
<td>Political, Institutional, and Cultural</td>
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<tr>
<td>6) How much do you agree with the following statement: The world’s</td>
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<tr>
<td>population growth is a problem.</td>
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<td>7) Within the past year, about how many different projects have you</td>
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<td>(through school organizations, class projects, volunteer work, etc.)?</td>
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<td></td>
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<td>involved in some kind of environmentally destructive behavior to stop</td>
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<tr>
<td>that activity?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Ecological</td>
<td>Social</td>
<td>Economic</td>
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<td>-------------------------------------------------------------------------</td>
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</tr>
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<td>10) Within the past year, about how often have you encouraged others to take an action on behalf of the environment?</td>
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<td>14) How often, by choice, do you keep thermostats set at energy conservation levels and/or limit your use of air conditioning?</td>
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<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Ecological</td>
<td>Social</td>
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<td>-------------------------------------------------------------------------</td>
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<td>X</td>
<td></td>
<td></td>
</tr>
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<td>16) How often, by choice, do you carpool instead of driving alone?</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
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<td>17) How appropriate do you feel it is for your school to promote recycling activities?</td>
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<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>18) How appropriate do you feel it is for your school to promote the need for conservation of natural resources?</td>
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<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>19) How willing are you to do more on behalf of the environment?</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>20) Which would best explain your personal motivation for becoming involved in sustainability type behaviors?</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
## Appendix C

Matrix for Assessment of Logbook Entries

Assessor Initials: ______  Student ID Number: ______  Entry Number(s): ______

<table>
<thead>
<tr>
<th>Domain / Objective</th>
<th>Key Ideas of Green Building</th>
<th>Process/Requirements of LEED Certification</th>
<th>Design/Model buildings utilizing Optimum Value Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological</td>
<td></td>
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</tr>
<tr>
<td>Social</td>
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</tr>
<tr>
<td>Political, Intuitional, and Cultural</td>
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</tr>
</tbody>
</table>
Appendix D

ITEA Construction Technologies “Seeing Green” Learning Cycle Objectives

According to the ITEA (2006), with the completion of this learning cycle, students will be able to:

1) “Identify the key ideas of green building.”

2) “Describe the process and requirements of LEED certification.”

3) “Design/model buildings that utilize Optimum Value Engineering.”
Appendix E
Parental/Guardian Permission and Student Informed Consent Form

**Study Title**  
Effect of Sustainable Design Learning Cycle on Construction Students’ Attitudes Regarding Sustainability

**Study Purpose and Rationale**  
The purpose of this research project is to examine how instruction affects students’ attitudes toward and knowledge of sustainability. Findings from this research could be used by educators to determine if instruction in their classrooms would have a similar effect.

**Inclusion/Exclusion Criteria**  
To be eligible to participate in this study, your student must be enrolled in the Residential Construction course.

**Participation Procedures and Duration**  
For this project, your student will be asked to take a pre and post test attitude survey related to sustainability. Students will receive instruction in the form of a learning cycle Where they complete activities related to sustainable design in residential construction. Students will complete a logbook regarding their experiences. All of this was take approximately fifteen class periods. The choice to participate in this study will not lead to any different treatment, or to any more or less work for the student. It merely grants The researcher permission to use the test results and other information, after students’ names have been removed.

**Disclosure of Alternative Procedures**  
Given that this procedure is part of the normal coursework, students choosing not to enroll will still participate in the above procedure, but their pre and post tests will not be included in the study data.

**Data Confidentiality or Anonymity**  
All data will be maintained as confidential and no identifying information such as names will appear in any publication or presentation of the data. Informed consent forms will be collected by a third party, ensuring that the instructor/researcher is not aware of who has chosen to participate until all final grades have been recorded.

**Storage of Data**  
Paper data will be stored in a locked filing cabinet in the researcher’s office for three years and then be shredded. The data will be entered in to a software program and stored on the researcher’s password-protected computer for three years and then be deleted. Only the researcher will have access to the data.
**Risks or Discomforts**
There are no anticipated risks of this study. Your student will be informed during the process that he or she may choose to withdraw from the study at any time.

**Benefits**
One benefit your student may gain from participating in this study may be a better understanding of sustainability and sustainability practices.

**Voluntary Participation**
Your student’s participation in this study is completely voluntary and you are free to withdraw your permission at any time for any reason without penalty or prejudice from the researcher. Please feel free to ask any questions of the researcher before signing this Parent/Guardian Permission form and at any time during the study.

**IRB Contact Information**
For one’s rights as a research subject, you may contact the following: Research Compliance Sponsored Programs Office, Ball State University, Muncie, IN 47306, (765) 285-5070, irb@bsu.edu.
Study Title Effect of Sustainable Design Learning Cycle on Construction Students’ Attitudes Regarding Sustainability

Parent/Guardian Consent
I give permission for my student to participate in this research project entitled, “Effect of Sustainable Design Learning Cycle on Construction Students’ Attitudes Regarding Sustainability.” I have had the study explained to me and my questions have been answered to my satisfaction. I have read the description of this project and give my permission for my student to participate. I understand that I will receive a copy of this informed consent form to keep for future reference.

___________________________
Parent/Guardian Signature

___________________________
Date

Student Assent
The research project has been explained to me and I have had the opportunity to ask questions. I understand what I am being asked to do as a participant. I agree to participate in the research.

___________________________
Student Signature

___________________________
Date

Researcher Contact Information
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Department of Technology
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Telephone: [withheld from thesis]
Email: [withheld from thesis]