A descriptive study of students' perspectives on controversial issues embedded in a college environmental science course

Chyrisse P. Tabone
University of South Florida

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A Descriptive Study of Students' Perspectives on Controversial Issues Embedded in a College Environmental Science Course

by

Chyrisse P. Tabone

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy Department of Secondary Education College of Education University of South Florida

Major Professor: Barbara S. Spector, Ph.D.
Elaine V. Howes, Ph.D.
Valerie J. Janesick, Ph.D.
Chérie L. Onkst, M.D., J.D., M.P.H.

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Dedication

I dedicate my dissertation, with love, to my mother, Vernetta J. Mullins and my grandparents, William H. and Rosalie Tabone.
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This qualitative study described non-science undergraduate majors’ responses to controversial issues embedded in an introductory level environmental science course in a liberal arts college located in the southeastern United States.

Participants enrolled in this 12-week summer course were both traditional college-age (late teens to early twenties) and non-traditional age student (thirties to fifties). Approximately 76 percent were female. Students demonstrated various lifestyles (e.g., gay, single-parent, living at home), socioeconomic statuses (e.g., middle-income, low income), employment (e.g., employed, unemployed, ex-military) and ethnicities. The structure of the environmental science course was consistent with the science education reform movement standards applied to K-12 public schools, but not yet pervasive in higher education. Some of the reform techniques included use of open discussion format, cooperative learning, field trips, classroom demonstration, and various media. The theoretical framework for the study was using controversial issues in science to stimulate cognitive dissonance, which may provide a pathway to higher level reflective thinking. Controversial issues triggering a response in students showed elements of injustice and unfairness. Examples included the CHEERS pesticide study on children in Jacksonville, Florida; human radiation
experimentation, including the use of depleted uranium in military conflicts; and local groundwater cases that exhibited environmental racism. The study showed the use of controversial issues in the environmental science course stimulated reflective thinking and encouraged the expression of environmental advocacy beyond the classroom. Students expressed participation in energy and water conservation, recycling practices, political involvement, and joining environmental groups. Students shared information with outsiders, such as family, friends, and co-workers when they deemed it personally or societally relevant (e.g., pertaining to family, health, safety, homelife, politics). Generational differences in students were observed in their openness to discuss controversial issues, ability to self-express, attitude toward the environment, quality of writing, and involvement in the educational process.
Chapter One—The Problem Statement

Personal Background

I have always been intrigued by science. When I was a little girl I used to read through my set of *Childcraft* encyclopedias which featured arts and crafts and homegrown science experiments. I would often pick up gravel from the playground at my elementary school and look for fossils. I actually found a few limestone pebbles with leaf imprints, which I proudly kept in a jewelry box for many years.

As a high school student, I passed the time by playing piano, guitar, and working on art. Writing poetry and short stories became my new love. When I began college with the intention of studying journalism, I discovered the perks of being “Editor in Chief” of the college newspaper. I could use the press pass to enter concerts and speak to bands. I could get free entry to plays to review the shows. Life was good.

Somewhere along the path, I re-discovered the world of science and switched my major to environmental science. I have worked professionally in the industry for over 20 years. Having acquired a Master’s degree in Science Education and now advancing my teaching methodology through my doctoral studies, self-reflection has prompted a lot of questions about science and society. I wondered how a person with a strong background in the humanities,
particularly music and the arts, could create a career in the sciences. What triggers a person, whether in academia or simply in his/her daily life, to spark an interest in science? With our lives surrounded by science issues in the news, how can one decipher what is factualism and what is bunk? Is science a separate entity from the rest of the world, or society, or simply a process for constructing an evidenced-based “truth”? The last few years in this country, science has been under attack by conservative America. The teaching of evolution in our public schools has been hotly debated and new pseudo-theories, such as “Intelligent Design,” have infiltrated our vocabulary. Global warming has been deemed as “scientifically inconclusive” by those in power in the United States (Armitage, 2005). Advancements in embryonic stem cell research have been stifled in this country due to “moral implications” (Petros, Grabowski, & Grunt, 2004). A woman in a vegetative state named Terry Schiavo was artificially kept alive for almost 12 years because medical technology allowed it. In 2005, a Romanian woman at age 67 gave birth to a baby daughter with the aid of fertility technology (Philipkowski, 2005). With our society dependent on scientific and technologic innovation, would it make sense to educate our student population in science, technology, and society? Since young adults will eventually be citizens participating in democracy, would it make sense to discuss the issues they will have to face?

These reflective questions are the catalyst for my dissertation and have
prompted my continued probing into science reform methods to “wake up America.” Thus, the force that drives my dissertation study is both personal and professional. The study is grounded in who I am, as an individual with the beliefs and values of an environmentalist and social activist. I have integrated my professional life as a college instructor into my personal goals of promoting education, enlightenment, and altruism. This is my worldview as I approach this study. As a science education researcher, I use science education reform methods in the undergraduate environmental science course I teach. The results of the study have the potential to assist science educators in promoting science literacy in non-science majors and provoke critical thinking at the college undergraduate level.

Since my heart is in the humanities and my professional background is in the sciences, I combined both in my dissertation writing. Richardson (2000) notes science is one lens and creative arts is another and we can see more deeply using both lenses. I have chosen a narrative writing style and first person voice to describe my findings, because through the introduction of personal stories, narrative inquiry allows researchers to build larger frames of reference and examine underlying assumptions and beliefs that guide our actions. Narrative inquiry captures the human experience and is a method for exploring systemic change and the design of educational systems from the perspectives of the facilitator of the change process. (Gill, 2001)

Richardson (2000) states self is always present, no matter how much we try to suppress it. People who write are always writing about their lives, even when they disguise this through the omniscient voice of science or scholarship
(Richardson, 2000, 2001).

In addition, I have entwined a musical theme throughout this composition as a “post-modern” metaphorical instrument of expression. The song lyrics in the text are meant to be decorative and stylistic, not interpreted literally. This practice reveals my perception of a need to soften the boundaries among disciplines and writing genres reflecting the way science, technology, and society are melded in real life.

**Context of the Study**

Since the 1950s, public opinion of science and technology has been one of fascination and mystique. After the onset of the nuclear age, pop culture presented science and technology as a counterpoint to nature. Science fiction aggrandized the horrid effects of “science gone bad” with movies such as “The Fly” and “Them.” The media sang the aria of the laments of science and space, when Buchanan and Goodman recorded the novelty production “Flying Saucer the 2nd.” As a child, I used to play the 45 RPM record on my portable monaural record player, and lip-synch the words as follows:

**Buchanan:** We interrupt this record to bring you a special bulletin. The reports of a flying saucer hovering over the city have been confirmed. The flying saucers are real!

**Radio:** Too real, when I feel, what my heart can't conceal... (from the Platters' "The Great Pretender")

**Buchanan:** That was the Clatters' recording, "Too Real!"

As the Environmental Revolution unfolded in the 1960s, the human to
creature to environment connection emerged. Technology was emblazoned and held with esteem as “2001 Space Odyssey” arose in the pop culture scene. The media began to play an apocalyptic melody with movies such as the “Planet of the Apes” series. The lyrics to 2525 (Exordium and Terminus) by Zager and Evans echo the fears of the time

In the year 2525
If man is still alive
If woman can survive
They may find…

*The Science and Social Connection.* It was in the late 1980s when *Science for All Americans* (1989) specifically stated science education reform promotes the concept of science as a human enterprise, an idea that postures science as a connection to social change, social conflict, and politics. Traditionally in undergraduate education, science is not associated with issues studied in political science, sociology, history, and economics. In actuality, all of these disciplines have been territorially held close to the breast and their integration in science education curricula has been viewed by science instructors as “watered down” science.

The social connection to science is the first step toward promoting scientific literacy, values, and attitudes. Science education can be used to foster three of these attitudes and values—curiosity, openness to new ideas, and informed skepticism (AAAS, 1989). Science, technology, and society education (STS) encourages discourse in science, assisting in communication of ideas through verbal discussions, graphical depictions, and illustrations (Pedretti,
Science and technology are two sides of the same coin when interacting with society. One might expect the connection between STS, but in science education, this has not often been the case.

Through scientific “habits of mind,” critical-response skills are boosted as students develop problem-solving skills that may be incorporated into their daily lives. Evidence, quantitative considerations, logical arguments, and uncertainty may be used as a rational path toward construction of new knowledge. Through scientific “habits of mind” education, students can be armed with the necessary tools to become independent thinking citizens who are capable of sifting through simple or complex “real life” problems. They may be able to galvanize themselves from falling prey to flimflam artists and purveyors of poppycock.

The Environmental Education Experience. Environmental education provides a perfect backdrop for introducing STS and controversial environmental issues into curricula. For example, Gayford (2002) notes global climate change (GCC) as controversial in nature both from a scientific and political standpoint, raising a wide range of social, economic, cultural, and ethical issues. He continues stating the underlying tension regarding the nature and purpose of teaching controversial issues may provide an instrument for behavioral modification in students. He believes students may find it liberating to explore and develop their own values, attitudes, and behaviors associated with critical thinking. It may be very challenging for a student to contemplate and ruminate over issues that have relevance to not only science but also their daily lives. As
a democratic citizen, it is imperative for students to be familiar with issues that affect their country and global nations. In this erratic world today, citizens face the price of extreme and unpredictable weather conditions, rising seas, and loss of ecosystems due to anthropogenic causes. We as educators need to arm students with the tools to comprehend the consequences of global warming.

Typically, in environmental courses at the undergraduate level, controversial issues are not discussed. From my observations and experience taking environmental courses over the last 25 years, topics such as global warming may be discussed, but strictly at the scientific level. The ethical, political, and sociological viewpoints are overlooked. The curricula are text-book driven and lectures are instructor-centered. Open classroom discussions are normally held in graduate courses only because undergraduate environmental instructors appear intent on spoon-feeding scientific facts to students for test taking purposes. Instructors do not act as facilitators to encourage extracurricular inquiry. A term paper, which students view as a means for earning a grade, may be assigned to offer an in-depth look at the subject of science. The whole educational process is very “dry” and uninspiring, and unlikely to be attractive to students who are not already committed to science as a major. Science education reform techniques, as recommended in *Science for All Americans* (1989), have the potential to entice more people to science and inspire science literacy.
My experience taking environmental science courses in higher education became the impetus for my dissertation study. It prompted the purpose of my study: describe the ways non-science majors in an undergraduate environmental science course respond to embedding controversial issues in the curriculum of a course consistent with the science reform movement.

For the last year, I have been teaching an environmental science course which is required for all non-science majors enrolled in liberal arts programs. The undergraduate majors include the following: accounting, business management, medical billing, paralegal studies, computers, and criminology. I designed a course with three aims: 1) embedding controversial issues within the curriculum, 2) using science education reform methods (e.g., cooperative learning, discussion, reflective writing, and informal science education), and 3) creating a class with relevant information to create scientific literate citizens. I aim to teach the environmental science class in the format I always wished for…and be the environmental science teacher I always wished I had.

The environmental science course introduces the students to concepts of ecosystems, lake eutrophication, global warming, sustainability of the environment, solid waste reduction and recycling, fossil fuel dependency and alternative fuels, public environmental health risks, consumerism, and hazardous waste generation. The college where I am employed requires use of a designated textbook *Environmental Science toward a Sustainable Future*, but gives me “free reign” to design the course as I see fit.
The first 45 minutes of class instruction is devoted to oral readings of newspaper clippings of current science news events and politics. After the readings, students are provided with an open forum for discussion of the introduced issues. I act as moderator and ask probing questions, attempting to keep the dialogue flowing. Emphasis is stressed on bioethical issues related to human experimentation, especially controversial science practices used in the United States during the past 70 years. Current political controversial issues discussed in the course include the following: mining limestone in the Everglades, logging in national forests, drilling for oil in the Gulf of Mexico and Alaska, use of depleted uranium and white phosphorus weapons in Iraq, Gulf War Syndrome, Hurricane Katrina and its aftermath, pesticide testing on children in Jacksonville, the Teflon® controversy, and the bombing of Hiroshima and Nagasaki.

The science content is delivered through Power Point presentations, traditional board lectures, short video presentations, in-class demonstrations, and interactive group activities. Throughout the lecture, students are encouraged to ask questions and discuss issues as topics emerge.

The college where I teach does not utilize Blackboard or any equivalent website-based teaching forum. I email my students the Power Point presentations in advance, announcements, and links to interesting environmental articles. Communication via email is greatly encouraged.

My goal is to create a classroom atmosphere that is warm, friendly, and
informal. I try to be approachable to the students and invite students to express themselves. I do demand “raising hands” and respect for all students involved in discussions. I frequently relay personal stories of my environmental field experiences and my personal life (i.e., activism) as the school quarter proceeds.

To lighten up the science content in the lecture, I embed comical animal photos and cartoons to provide laughter and “wake up” the students. Feedback from the students denotes they “get a kick” out of this and pay attention to see when the photos will show up.

Being supportive of informal education, one optional field trip to a local reclaimed water sewage treatment facility is offered to students on one Saturday morning each school quarter. Extra credit is received by students who attend the event. I encourage students to bring a friend, spouse, significant other, or a teenage son or daughter to share the experience. During a recent field trip, students brought fathers, children, and spouses, to share the experience.

The sharing connection in education is expressed in my philosophy “Education is a family experience.” During the 19th century, the school belonged to the community and the community belonged to the school (Tyack, 1974). Students have told me “I always tell my husband about what we discuss in class” or “My teenage daughter would really love this class.” I have encouraged and hosted family members to share the college experience with loved ones by sitting in class for the “experience.” When I was an undergraduate, my mother and I took a college class together “for fun.” I recently invited her to observe my
teaching for constructive criticism and feedback.

For assessment purposes, I assign weekly homework questions either I create or are listed in the textbook. The answers are discussed during the following class session. Two term papers related to a current environmental or public health issues and one comprehensive exam create most of the course grade.

In addition, students are required to write weekly “reaction papers” to provide an outlet for reflection and reaction to the issues discussed in each class session. Since controversial issues are openly discussed in class, students may want to vent or “react” on paper. Students may hand in papers on a weekly basis (either in hand-written or email format) or at the end of the quarter in a bound diary. This provides the student with an outlet for self-reflection, expression of viewpoints, and individual student-teacher dialogue. From my experience, students in the course have viewed the “reaction paper” process as positive, articulating the need for discourse and expression without the fear of peer judgment. If the reflective process is expressed via emails, a dialogue often ensues between the student and me, creating a personal relationship.

Special emphasis throughout the quarter of instruction is on “real life” issues and practical application of environmental science. Examples of practical information include: 1) methods of household water conservation, 2) in-depth study of sinkholes (e.g., in-class demonstration model), 3) plastics recycling and coding system, and 4) survey of household “hazardous” wastes.
The concept of environmental political involvement and activism is introduced to the classroom. Also, real-life local ethical dilemmas (e.g., benzene contaminated well at a former Stuckey’s) facing environmental professionals are presented through discussion of my personal experiences. Power Point presentations of my recent field excursions and personal case studies are embedded within science content to create a real-world experience.

**Purpose of the Study**

The dissertation study describes and explains the ways non-science majors in an undergraduate environmental science course respond to embedding controversial issues in the curriculum of a course consistent with the science reform movement directed at K-12 public schools. The science course is required for all liberal arts degrees offered at a private college located in the southeastern United States. The class at the college is typically comprised of both traditional and non-traditional age students studying for an associates or bachelor’s degree. Additional information concerning the study will be explained further in Chapter Three.

**Research Question**

The dissertation study addressed the following:

How do the students respond to controversial issues embedded in the curriculum of an undergraduate environmental science course consistent with the science education reform movement?
Rationale for the Course Design

Reviews of literature in the areas of history and political science have shown that embedding controversial issues in curricula improves reflective thinking skills, argumentation, and debate (Werner, 1998). King and Kitchener’s (2004) Reflective Judgment Model provides the theoretical framework for assessing reflective thinking in the study. The theory will be further explained in Chapter Two.

Documenting students’ responses to the use of controversial issues in curricula may provide insight for higher education to make courses consistent with current reform principles. A descriptive study, particularly in environmental science, may shed insight into which topics strike chords with undergraduate students. Especially to those students who harbor values toward the topics discussed in class, exposure to these controversial issues provides a “dissonance experience.” Festinger’s Theory of Cognitive Dissonance (1957) provides the impetus for using controversial issues in the classroom. The theory will be further explained in Chapter Two.

Overall, the dissertation study may benefit science education researchers by answering the research subquestions. The research subquestions emerged as data were collected:

- Which features of controversial issues triggered responses?
- Were there signs of attitudinal changes and positive environmental actions?
• Were there any signs of skepticism and reflective thinking?
• Did generations react differently?

Another rationale for the course design was found when examining the demographic make-up of undergraduate colleges today. The line between traditional and non-traditional students is thinning as more students attend part-time, a high proportion of women are enrolling, and more students are over age 25 (Oblinger, 2003). Older students are arriving on campuses because many are returning to school to pursue mid-life career changes. Some students may be older due to combining part-time school and full-time work. Some women may return to college after their children have grown. My particular interest is in generational differences of students, since college instructors need to reach out to all levels with teaching methodologies.

Colleges and universities need to adjust instruction to accommodate the arrival of a new generation of students known as “Millennials.” The millennial students are those born between the early 1980s and the Millennium. Millennials are different from their predecessors the “Generation X’ers” and “Baby Boomers” because they were raised with technology, computers, and the Internet. The educational emphasis on standardized testing, as touted in “No Child Left Behind,” has resulted in rote memorization and de-emphasized critical thinking skills. Content material, and even traditional courses which create a “well-rounded education,” are eliminated to make time for standardized test preparation for English and math. Florida, along with Texas, North Carolina, and
a growing number of states are considered a leader in the high-stakes testing movement (Myers & Curtiss, 2003). By the time secondary students enter college, he or she may not have developed reflective thinking patterns.

In addition, stressing testing has robbed students of the notion that education prepares students for “democratic citizenship,” the essence of John Dewey’s (1933) educational philosophy. It is likely, too, the Millennials have had minimal experience with integrated science courses rooted with controversial issues (e.g., drilling in the Arctic and Gulf of Mexico, Plan B pill, medical marijuana, and embryonic stem cell research) as a foundation. Exposure to these issues may be the first step toward scientific literacy.

Traditional science education methods do not encourage students to pursue careers in science and technology. Similar to the late 1950s when the Soviet Union shocked the nation by launching Sputnik, the United States is entering another science education crisis. The United States, the once dominant superpower on the planet, has dwindled in the area of science and technology and is competing with Asia. China, which was once a nation dominated with bicycles for transportation, is now producing more scientists and engineers than any nation. China, India, and other countries are more explicitly strategic in creating competence and innovation centers ("Collaborative Advantage," 2006). China, South Korea, and Japan, have a different ethical and moral take on what it means to be human than the Judeo-Christian and Western traditions do (Selko, Spoor, & Bailery, 2006). For this reason, these countries are actively
participating in cutting-edge technology in regard to embryonic stem cell research, a technology which can not only assist in curing debilitating diseases but extend life longevity, intelligence, and physical abilities. As the United States once enjoyed global dominance and provided a range of cutting-edge technologies, foreign-born scientists, some whom were educated in American institutions, are paving the way for the future.

*Rationale for the Study*

Science education reform has shown repeated cycles throughout its history. After the United States suffered a “Sputnik realization” on October 4, 1957, the science reform movement crescendoed to a flurry of activity to overhaul the K-12 public school system. The National Science Foundation poured money into science curricula development and the country appeared to be on its merry way to scientific domination. In the 1970s, the science reform movement decrescendoed, but was later revived in the 1980s after a *Nation at Risk* (NCEE, 1983) denounced the condition of the American public school systems. Congress reacted by promoting Science Education Standards (SES) in the K-12 public school system, later to have its work sabotaged in the Millennium with the Bush administration’s “No Child Left Behind” act. The act promotes standardized testing. School personnel are focusing on creating competent test-takers, but not thinkers. Rote memorization and the absence of critical thinking are the norm as teaching emphasis is placed on “knowing the
correct answer.” Students are encouraged to memorize science content for large scale testing purposes without making connections to “real world” situations.

Although through the years there have been waves of science education reform in the K-12 public school system, it has yet to become pervasive in higher education. There appears to be a paucity of science education research studies examining the implementation of science education reform in the undergraduate science classroom. Even less common, are studies showing the effects of teaching controversial issues in the undergraduate science classroom. For this reason, my dissertation will contribute much needed research.

Definition of Terms

The definition of terms and phrases used for the purpose of the study are presented as follows:

• Baby Boomers—Baby Boomers (Boomers) are those born between the years 1943 and 1963. According to Howe and Strauss (1991), the Boomers are “idealists” and their awakening arose in “rising adulthood stage.” There are approximately 79 million Boomers in the United States. Influences in their early adulthood include advances in science, the “sexual revolution,” Vietnam War, hard rock, a rise in accidental death rates, and increased college education. As the Boomers aged, they sought comfort in New Age and evangelical sects, with many turning toward conservatism and “moral policing.” On the other hand, there are still Boomers who have not shed their ideological stripes and beckon
social activism for environmental causes, animal rights, gay rights, and anti-war movements.

- Belief in Just World Theory—“Belief in Just World” (BJW) is a theory that people have a cognitive and motivational need to believe they live in a “just world” (Dittmar & Dickinson, 1993; Lerner, 1965). Rooted in Cognitive Dissonance (Festinger, 1957; Furnham, 1993, 2003), Marvin Lerner’s BJW theory is applied in the field of social psychology and criminal justice. Lerner believes BJW is universal and may be attributed to social institutions, such as the Protestant Work Ethic. Those with a high belief in BJW are generally politically conservative, viewing underprivileged groups of people as responsible for their situation (Dittmar & Dickinson, 1993; Furnham, 1993, 2003).

- Cognitive Dissonance—Cognitive Dissonance is a psychosocial theory describing the feeling of conflict in one’s belief system when values are challenged, resulting in tension that must be eliminated (Festinger, 1957). People going through cognitive dissonance will find some rationale for whatever is causing the conflict, or may choose to ignore the event in question altogether. Festinger believed that people want balance in their lives and consonance was a way to bring back a lost sense of balance. Cognitive dissonance occurs in situations when new information becomes known to a person, creating at least a momentary dissonance with the existing knowledge, opinion, or cognition concerning behavior (Festinger,
Dissonance may arise from a logical inconsistency, cultural mores, a specific opinion, or past experiences.

- Environmental science class inventory—An Environmental Science Class Inventory is a survey-like “snapshot” of the population, thus, assisting in data crystallization for providing trustworthiness (Lincoln & Guba, 1985; Richardson, 2000). The inventory describes demographics, attitudes and beliefs of the non-science majors enrolled in the study.

- Explicit memory—Explicit memory is the controlled or conscious memory a person utilizes to involve vivid recollections of specific items as part of previously presented educational material (Brainerd, Stein, & Reyna, 1998). Psychological evidence shows emotion positively influences episodic memory function (Dolan, 2002). This may yield support to the use of controversial issues in the classroom.

- Generation—A generational cohort-group is a phase of life in terms of social roles. Generations are regarded as 22-year phases, as follows: Rising Adulthood (age 22—43), Midlife (age 44—65), and Elderhood (age 66—87). Rising adulthood is a time of activity (working, starting families and careers, serving institutions, and testing values). Midlife is a time for leadership (parenting, teaching, directing institutions, using values). Elderhood is a time for stewardship (supervising, mentoring, channeling endowments, and passing on values) (Strauss & Howe, 1991).
• Generation X’ers—Generation X’ers are those born between the years 1964 and 1980. According to Howe and Strauss (1991), the Generation X’ers are “reactive” and their awakening arose in “youth.” There are approximately 93 million Generation X’ers in the United States. Influences in their early adulthood include extended families due to divorce, working mothers creating “latchkey kids,” and a decline in college education completion. This generation, who saw their workaholic parents rewarded with downsizing and mergers, are often called “cynical” and “slacker” (Jurkiewicz, 2000). There seems to be minimal available information concerning the aging Generation X’er but Jurkiewicz (2000) notes that Generation X’ers are perceived as having a poor work ethic, committed to “self” rather than an employer, and value individualism over collectivism. In addition, this generation grew up with little financial or family stability and no real solid traditions.

• Justice—Justice is moral rightness, equity, fairness or conformity with what is right or legal (“The American Heritage Illustrated Encyclopedic Dictionary,” 1988).

• Millennials—Millennials are those born between the years 1981 and the present. According to Howe and Strauss (1991), the Millennials are “civic” and their awakening period is not yet known. There are approximately 76 million Millennials in the United States and growing since fertility drugs in the 1980s helped create this “special” generation. Influences of the
Millennials include pressure to achieve, computers, Internet, sheltered upbringing, and the return of convention (Howe & Strauss, 2000).

• Reflective thinking—Reflective thinking is active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends. (Dewey, 1933, p. 6)

The concept, first introduced by John Dewey in the 1920s, was later drawn upon by Patricia King and Karen Kitchener in the 1980s as Reflective Judgment Model (Kitchener, Lynch, Fischer, & Wood, 1993)

The Reflective Judgment Model describing three phases of reflective thinking: 1) pre-reflective thinking, 2) quasi-reflective thinking, and 3) reflective thinking. Each level relates to a path of intellectual independence toward critical thinking.

• Scientific Habits of mind—Scientific “habits of mind” are the attitudes, skills, and methods of thinking that are essential to science literacy (AAAS, 1989). Project 2061’s 1989 publication Science for All Americans. Science for All (1989) report states scientific habits of mind can help people in every walk of life to deal sensibly with problems that often involve evidence, quantitative considerations, logical arguments, and uncertainty; without the ability to think critically and independently, citizens are easy prey to dogmatists, flimflam artists, and purveyors of simple solutions to complex problems.
• Truth—Truth is generated at the level of the individual (McGettigan, 2000). According to McGettigan (2000), truth does exist and can be produced by anyone, not just scientists, who actively overcome the influences of social power that limit the boundaries of understanding.

Summary

Undergraduate college instructors may be qualified to teach environmental science or other disciplines, but they may not be instilling science literacy and reflective thinking skills through their current instructional methods. The science education reform techniques described for K-12 public schools have not been pervasively used in higher education. Ella Fitzgerald may not have been speaking of undergraduate science reform methods but she addresses the issue when singing,

'T ain't what you bring, it's the way that you bring it
'T ain't what you swing it's the way that you swing it,
'T ain't what you sing, it's the way that you sing it,
That's what gets results. (T'aint what you bring)

My intent was to study the effects of embedding controversial issues in an undergraduate environmental science course for non-science majors. The format of the environmental course reflected the science education reform standards applied to K-12 public schools. I described the students' responses to the applied science reform methods and “dissonance” techniques.
Chapter Two—Review of Related Literature

Introduction

The literature informs the reader of the history of the science education reform movement, which has had twists and turns from its first note sung to its latest reform stanza of the 1980s. Environmental education, the focus of my literature review, is one of science education reform's operatic attempts to scale the bar and bridge the gap between science, technology, and society.

By implementing science reform techniques in undergraduate science courses, such as introducing controversial issues into the curriculum, cognitive dissonance may be stimulated. Emotion may inspire. Reflective or higher level thinking, as promoted in the science reform movement, may grab hold. Our university systems now serve a polyrhythmic mix of diverse cultures, genders, and ages of students. A stanza of learning and reflection of a Science for All may be achieved for both traditionally-aged and non-traditionally aged students.

To understand the interplay of science education reform, using controversial issues in the classroom, and the effects of their use, a concept map has been prepared for the literature review. The concept map may assist the reader by outlining the researched topics in an organized graphical display. Please see Figure 1, Concept Map of Literature Review.

So, let the music begin…
Figure 1. Concept Map of Literature Review
Problems with Undergraduate Science Education

Since state public school systems have mandated science education reform, the emphasis of most recent wave (the last 25 years) has been toward K-12 schools. In the United States, the national reform movement may be described in *National Science Education Standards* (NRC, 1996a), *Benchmarks for Science Literacy, Project 2061* (AAAS, 1993) and *No Child Left Behind* (U.S. Department of Education, 2001). What has been missing from the reform process is broadening the effort to include the university level courses (Wright, Sunal & Day, 2004). Undergraduate introductory science courses are of particular importance since they may provide stepping stones to either higher level science courses or may be the sole course taken by a non-science major. These courses may serve as weed out courses, which may turn off students from entering the fields of science and technology. In addition, these courses may not provide the necessary tools to prepare an undergraduate science student to act as a science literate citizen.

Certain elements are responsible for driving students out of introductory science courses as follows: lack of relevance, relegation of students to passivity, emphasis on competition, and a focus on algorithmic problem solving (Tobias, 1990; Wright, Sunal & Day, 2004). A National Science Foundation report, *Shaping the Future* (NSF, 1996), reported that scientists needed to make undergraduate science courses more meaningful for both science and non-science majors.
The Society of College Science Teachers (SCST) examined the problems of introductory science curricula and formulated recommendations to improve courses (McCormick, 2004). Their position paper stated these science courses lay the groundwork for major recruitment. In addition, this is where preservice teachers either learn to love or hate science. The SCST recommended including research-based formats to promote critical thinking, problem solving, and collaborative work in undergraduate science courses.

Inquiry-based science classes may benefit non-science majors by enabling empowerment, thus, lessening the science-fear anxiety (Waggoner, Schaffner, Keller, & McArthur, 2004). Most students in non-major courses will not continue to take additional science coursework, but an attitude toward science may be created or destroyed in an introductory course. Since most non-science majors are required to enroll in only one science course, this may be their only opportunity to obtain the inquiry or process skills necessary for science literacy. Student science journals may be their only opportunity to receive feedback on their inquiry methods, as one student stated, “I plan on keeping my lab journal to use in other science classes…This class has prepared me to think more scientifically and critically” (Waggoner et al., 2004).

In August 1997, the Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT) was funded for five years as part of the Collaborative for Excellence in Teacher Preparation (CETP) program of the NSF (Wainwright, Morrell, Flick, & Schepige, 2004). The program aimed to determine
if the elements of reform teaching were being used by college faculty members teaching undergraduate science and mathematics courses. Participating instructors attended summer institutes utilizing reform-based practices which fostered reflection on current issues in science, mathematics, and technological literacy for K-16 teaching.

Wainwright et. al. (2004) conducted observational sessions and interviews with the teachers, concluding that some reform teaching strategies were being implemented at the college level. When compared to the mathematics classes, science classes frequently exhibited interdisciplinary connections, pedagogical content knowledge and multiple representations of concepts. The science lecture classes (the primary mode of instruction observed) had the lowest frequencies of student discourse and collaboration (unlike the mathematics classes which used small groups). The size of the science classes did not determine if reform teaching strategies were being implemented. For example, the class with 250 students showed frequent use of reform strategies as compared to the classes with 20 students or less. Since classes are predominantly lectures, the researchers suggested that teachers offer discussion-oriented formats which lend to student-student interaction and emphasis on student input.

Waggoner et al. (2004) discuss that introductory geology courses are normally lecture format with cookbook or verification laboratories. From personal experience in taking graduate level geology courses at state universities in
Florida, I would venture to say this stale approach extends into advanced courses too. Waggoner et al. (2004) believe the traditional geology courses are not conducive to fostering long-term retention, critical-thinking skills, problem solving, and developing the inquiry nature of the discipline. The researchers constructed a geology course using a science reform approach fostering both informal and formal cooperative learning strategies. The use of active learning with cooperative teams benefits undergraduate students’ achievement through gained confidence in defining and solving problems (Goldston & Clement, 2004; Pinet, 1995). MacDonald and Korinek (1995) discovered that incorporating cooperative writing activities enhanced student geology content, reduced student isolation, and fostered communication skills. In a sense, the social interaction provided the experience of articulating scientific reasoning in both oral and written formats. Since Project 2061 advocates scientific literacy for all students, the MacDonald and Korinek (1995) found their approach to be conducive to scientific inquiry and extended problem-solving.

Encouraging activities that bridge the science subdisciplines and focus on critical issues relevant to all disciplines, faculty at the University of Idaho developed an Integrated Science course for non-science majors and preservice teachers (Graves, Odell, Ewers, & Ophus, 2004). The college course is aligned with the science standards for the state of Idaho and NSTA’s College Pathways to the Science Education Standards. For the entire semester, the course centers on a studying local watershed, Paradise Creek, and reinforces the scientific
experience with weekly field activities. The in-class activities include open
discussions so students can explore the human-environment interactions. At the
end of the semester, student groups presented a poster session or Power Point
presentation of their watershed study. The presentations included graphs and
surveys of local flora and fauna.

The University of Idaho Integrated Science course serves as an example
of environmental science at work. In recent years, universities offer both
Environmental Science and Environmental Studies degree programs. There is a
distinction between the two because the science programs require traditional
science coursework in chemistry, biology, and geology. The studies program
consists of coursework focusing on the philosophy of environmentalism, ethics,
and policy.

*Using Controversial Issues in Courses*

It was not until graduate school that I first experienced a discussion format
course. Most of the specialty courses were directly related to my major study
and were not the lecture hall required courses. It felt empowering to offer an
opinion and hear those of my fellow students, because for the first time we were
considered living, breathing adults with a voice. Any questions we may have had
concerning an issue or topic were immediately addressed by either the professor
or classmate. It appears at the graduate level, students are considered to be
mature and prepared to discuss any type of topic, whether mundane or
controversial in nature.
Conversational learning enables students to create new understandings and transform their varied experiences into resources for change and learning (Baker, 2004). According to Baker, Jensen, & Kolb (2002), the theoretical foundation of conversational learning rests on the premise that learning and increased understanding can be achieved through the interplay of opposites and contradictions. Students engaged in discussions can push the boundaries of conversations, allowing exploration of opposing ideas from various participants. The researchers believe that educational and organizational settings should allow people with differing ideas and experiences a voice creating substantive content for conversational learning (Baker, 2004).

The use of hotly debated topics in the classroom is not novel, but the central feature of school-based democratic education. According to Hess (2004), the U.S. Bureau of Education issued a bulletin in 1916 entitled ‘Problems of Democracy,’ encouraging the emphasis of contemporary political issues in the classroom. She continues citing evidence that discussions of controversial issues promotes democratic thinking, development of tolerant attitudes, and appears to influence political engagement (Hess, 2004; Hodson, 1999; Jickling, 2003; Payne & Gainey, 2003). Discussion of controversial issues may be procured in a history or political science class, but rarely do students discuss heady topics in a science class! A vibrant democracy depends on this participation, which is the very expression of discomfort and controversy (Jickling, 2003).
My mother, who was proper and etiquette-minded, warned not to discuss money, politics and religion in polite company. I was never told exactly where one could discuss such forbidden subjects or with whom. Is discussing politics or religion in a science class permissible or ruled out? According to Evans et al (1999), topics which are taboo or forbidden from discussion due to sensitivity exert control on our everyday lives. This may extend into our schools, reinforcing the off limits perception of taboos.

Taboos determine culturally what is acceptable and unacceptable; from an anthropological perspective, they serve as an insulator of perceived harm, whether rational or irrational (Evans, Avery, & Pederson, 1999). With a multicultural society sharing differing religious or cultural beliefs, moral issues embedded within science are hotbeds for flaring emotions. According to Evans, Avery & Pederson (1999),

A system of taboos imposes severe disabilities on teaching and thinking in [science] classrooms, whereas, loosening or breaking taboos has the potential for freeing the human mind and helping to make teaching and learning science stimulating and exciting. (p. 219)

Oulton (2004) points that teaching controversial issues in science needs to take explicit account of their nature, emphasizing the following: 1) groups within society hold differing viewpoints based on different sets of information and interpretation and 2) differing worldviews can occur because the individuals adhere to different value systems. Varying attitudes and value judgments of society are the roots determining if a topic is controversial or approachable for discussion. Oulton argues that controversial issues cannot always be resolved by recourse to reason,
logic or experiment and issues may only be resolved as new information becomes available. This formula for reason is directly in line with the NSESs philosophy concerning the nature of science. Oulton cites an example of a controversy in his native United Kingdom by referring to the slaughtering of cattle, sheep, and other farm animals after the outbreak of foot and mouth disease (FMD) in 2001. This complicated issue concerned government policy, the science of viral and bacterial infections in animals, the economics of beef industry, and the moral grounds of animal extermination. Different viewpoints arose among the groups involved, creating highly publicized accusations and emotionally charged debates.

Controversial issues, such as FMD, are often rooted in science concepts. Scientific developments or scientific endeavors in resolving problems are often intrinsically linked to social, political and economic concerns. The experimental nature of science and uncertainties that arise may create a lack of trust in scientists due conflicting information and misrepresentations expressed in the media (Oulton, Dillon, & Grace, 2004).

Cross and Price (1996) are concerned about teachers who present science as unproblematic and characterized as reflections of certainty. They believe a realistic portrayal of scientists and scientific endeavors is essential to show the complexities of the nature of science. Often in controversial issues, moral dilemmas arise, similar to situations a student may encounter after leaving school. These dilemmas test a student’s personal standards of character and conduct concerning right and wrong behavior. For this reason, schools may aid students in handling
questions of value, prompting judgments, and encouraging students to take responsibility for their own lives (Cross & Price, 1996). Students need to be armed with the tools to judge particular claims made and the agenda behind each, developing their own position based on the facts presented. Asking questions and doubting sources of information creates healthy skepticism, which is a desirable quality in the world of science.

Van Rooy (2000) discusses her research on incorporating controversial issues into an A-level (high school) biology course. Her goal for the class was that students would become conversant with personal, ethical, and social aspects of science/biology. Before using the moral dilemma of human organ transplantation, the students had completed a unit on human physiology, the circulatory system, and were beginning to work on the renal system. The students were given discussion questions that exercised science content knowledge (e.g., What medical technologies are used with transplantation? Do you know how they work?), but later evolved into moral dilemmas (e.g., Do you think the parents made an informed and sensible decision? Why?). Van Rooy created another dilemma regarding artificial maintenance of life, the definition of life and death, and organ donor and transplantation. The discussions delved into the comparison of physical characteristics (e.g., heartbeat, cognition, consciousness) versus moral and religious issues (e.g., loss of soul, sanctity of life). The interlacing of science with societal issues became apparent as the lessons showed the connective relevance between economic, cultural, ethical,
and other non-scientific issues. Van Rooy felt the medical and ethical issues discussed in class raised the interest level in science and provided the students with an opportunity to show their understanding of biological systems beyond the boundaries of the syllabus (Van Rooy, 2000). Learning how to talk constructively about controversial issues makes it easier to bring deeply embedded assumptions to the surface, sometimes to explore them for the first time (Baker, 2004).

Consequently, the instructor in Van Rooy’s study used the controversial issues in the biology class as “bolt-on extras.” The central issue for this teacher was his belief that very little substantial biological knowledge could be learned by students if controversial issues were used as a significant teaching strategy (Van Rooy, 2000). The teacher believed meaningful discussions in biology were not possible unless students were familiar with the subject matter first. Teachers sometimes resist teaching controversial issues in the classroom due to ingrained beliefs about what should be taught and the nature of biology. They may feel many of the controversial issues are taboo topics in the classroom, fearing uncomfortable discussing the topics. They may not want to deviate from the syllabus or textbook, risking opening a can of worms or receiving poor student evaluations at the end of the term.

Since many controversial issues have a basis in science, familiarity with the science content is essential for argumentation and debate. Students, who have a working knowledge of technical vocabulary and theoretical concepts
supporting a science or technology, develop a mature understanding, thus, promoting higher reflective reasoning. They realize issues are multi-faceted and factual information needs to be considered, as well as social and ethical implications. Students need to see there are occasions when no answer is correct or incorrect. Science, technology, and society are often colored in shades of grey. A comfort level may elevate if students believe science is in a state of flux, altering as new evidence arises.

Problems with Embedding Controversial Issues in Courses

Like Muddy Waters and bluesman often bellowed, “There’s trouble in mind….but the sun’s gonna’ shine in my back door one day.” Discussing controversial topics in the classroom may enervate most instructors, hence, many teach with the same moribund methods year after year. Many stay in their own comfort zone which is a disservice to aspiring students who may migrate to other disciplines due to unimaginative teaching.

Incorporation of controversial topics in the classroom, particularly those related to STS, is not without challenges. Some teachers may feel time constraints regarding incorporation of controversial issues into their formulated “safe” curriculum. This simply encourages the continuation of the same unreflective beliefs and prejudices (Werner, 1998). Instructors may have difficulties structuring the concepts involved into a coherent learning experience without destroying the established sequencing of science topics (Gayford, 2002). They may feel a loss of control and may lack the teaching skills more commonly
Balancing the arguments of controversial issue in science may be difficult for teachers who are particularly opinionated on topics, such as oil drilling in the Arctic, depleted uranium in artillery, or the effects of global warming. A lack of commitment, energy, and availability of resources (e.g., videos, articles, speakers) may discourage science instructors from incorporating controversial issues into the lessons. Teachers, who act as facilitators, may have difficulty making judgments about the content, particularly the non-scientific aspects that are important in helping students understand the nature of the issues involved (Gayford, 2002).

Some students may lack the experience of critical discussion and feel ill-informed, or perhaps not interested in the political on-goings in the United States. Others may not have experienced the opportunity to voice their opinions in a public forum, and feel self-conscious of classmates’ opinions. Few unbiased opinions and analytical discussions are presented in mainstream media concerning STS, particularly in the area of bioethics. Jickling (2003), an environmental educator, asks

How can an educational environment be created where students can be introduced to ideas outside of the mainstream political spectrum? Without a dialogue of issues outside of the “safe zone” purported by the educational school system, how can students have the practical tools to move beyond the alleged standards? If in the realm of environmental education, students do not discuss the methods of “Greenpeace” or “Environmental Liberation Front,” how can students consider the philosophical underpinnings of radical groups? (p.22)
Jickling (2003) argues that it may be easier to reduce environmental education to sanitized discussions by avoiding controversial issues and sticking to superficial topics. But, are you being fair to the students by offering a diluted curriculum? If science education is truly a value-laden entity, should we as educators intentionally stifle the moral issues embedded within the curriculum?

Although education historically has promoted democracy and citizenship, the institution is authoritative and does not encourage freedom of expression, discussion of controversial issues, and tolerance of opposing ideas. It is possible that this attitude stems from the hegemony of the institution, with the attitude that “Students should be seen and not heard” or “Shut up, listen, and take notes.” For this reason, some instructors may be reluctant to broach controversial issues in science. Class sessions may require additional lecture preparation and effort with the risk of retributions. Although in higher education an instructor does not normally have to worry about hovering parents, a disgruntled student may file a complaint.

The last few years in academia have been trying for professors who teach in the areas of liberal arts, particularly history and political science (Byrne, 2004; Hess, 2004). Academic freedom, which has been interpreted in judicial opinions as a constitutional right, is under attack. The American Association of University Professors (AAUP) stated in its 1915 General Declaration of Principles that the role of professors is as a scholar seeking truth to the light of scholarly disciplines, a teacher of nearly mature students, and an independent expert offering
guidance to the public (Byrne, 2004). The declaration promoted freedom to faculty in research, publication, and teaching. Since the onset of the millennium, David Horowitz, a crusader on the political right, introduced his “Academic Bill of Rights” to legislators in Colorado and Florida. Horowitz believes that the AAUP has recognized students rights since its inception but most campuses have rarely given them the attention or support they deserve (Horowitz, 2004). He believes that “radical left wing professors” are indoctrinating students and may “punish” students with conservative view points (Fish, 2004).

Byrne (2004) discusses Vega v. Miller, a case which involved a First Amendment challenge by an untenured professor to his dismissal for professional incompetence, by quoting a dissenting appeal Judge Cabranes:

Today the loser is a college teacher in a conservative academic setting who used an ‘alternative’ teaching technique with a profane effect. In the future, the major losers are likely to be ‘traditionalists’ and unconventional college teachers, whose method or speech is found offensive by those who usually dominate our institutions of higher education. The First Amendment, with its ‘special concern’ for academic freedom…must protect all college teachers, especially the performance of their most important duty—teaching in the classroom. (p.81)

In Spring 2005, I followed the “Academic Bill” HB 837 introduced into the Florida legislation by Dennis Baxley (R) with focused interest and white-knuckle fear. Much to my relief, the bill died on May 6, 2005. This bill personally threatened my academic interest in using controversial issues in the classroom purposely. The bill appeared to target liberal arts, but STS could fall into that category because it is an integration of science, technology, and social sciences.
An excerpt from Section 2, Section 1004.09(3), Florida Statues, is presented as follows:

Students have a right to expect that their academic freedom and the quality of their education will not be infringed upon by instructors who persistently introduce controversial matter into the classroom or coursework that has no relation to the subject of study and serves no legitimate pedagogical purpose.

As any section in a proposed bill, this could have a broad range of interpretations. To be on the safe side, I preface the introduction of controversial topics into the class session by stating its relevance to the class material. For example, the discussion of the United States’ bombing of Hiroshima and Nagasaki is a bioethical issue with relevance to the topic of radiation in the environment.

In an ironic twist, in graduate school I was subjected to “pretending” to be a Bill Clinton/Al Gore-hating student to stay on the “good side” of my major professor. I felt compelled to spit Rush Limbaugh and Glenn Beck quotations so my cover would not be blown. During these years, I did feel uncomfortable hearing the jabs that threatened my Democratic core, but I never felt victimized or driven to sue the professor and institution. In the university environment, we are adults and have the freedom to create our own opinions.

*Instructional Bias in Teaching*

If an instructor discusses the limestone quarrying in the Florida everglades or the drilling for natural gas three miles off the coast of Florida, does this show bias? How can one teach environmental science in a college classroom without
discussing the relaxation and lack of enforcement of environmental regulations since the year 2000? Critics of the use of controversial issues in the classroom or the encouragement of advocacy in environmental education say the educational system is indoctrinating students toward certain opinions, causing bias (Werner, 1998).

Bias is inherently in the curriculum by the simple choice of textbooks. Textbooks are normally written in favor of a particular interest group that benefits most from the way society is currently organized (Werner, 1998). Textbooks tend to favor the dominant culture and social, economic and political status quo.

Instructors play a critical role in the promotion of controversial issues in the classroom because they serve both promoter and filter of information in the classroom. Traditionally, teachers have embraced objectivity and neutrality, often omitting personal opinions to minimize influence. Oulton et al (2004) notes the use of some procedural neutrality was difficult for most teachers to sustain and threatened the rapport that had been built with the class. Payne and Gainey (2003) note an instructor’s self-exposure can be a tool used to break down anonymity of course material and the classroom setting. Additionally, they express that general comments about the teacher’s experiences with an issue can enhance critical thinking.

According to Hess (2004), perception of indoctrination through use of controversial issues in the classroom typically occurs in two different ways, including the viewpoint of the teacher (or teaching material) or the actual topical issue per se.
creates simple discussion as “indoctrination.” However, one person’s indoctrination might be another’s desire to present a vision of the truth (Oulton, Day, Dillon, & Grace, 2004). Instructors may teach students how to deal with controversial issues and adopt strategies for students to recognize bias, how to evaluate evidence, observe alternative interpretations and viewpoint.

Sometimes an instructor influences students by not choosing topics for discussion. The absence of covering issues in a science class speaks volumes. In the 1970s, I took an earth science course in high school that completely dismissed the topic of evolution. The science teacher did not discuss it at all and I remember asking him, “Aren’t we going to talk about evolution in this class?” He replied, “It is not appropriate to discuss in class.” Even in high school, I knew this was wrong and figured I would have to read about evolution on my own. Actually, a large portion of my high school education was acquired through extracurricular reading.

Elliot Eisner (1994) describes the three curricula that schools pursue—the existing, implicit curricula, and null curricula. He states:

there is something of a paradox involved in writing about a curriculum that does not exist. Yet, if we are concerned with the consequences of school programs and the role of curriculum in shaping those consequences, then it seems to me that we are well advised to consider not only the explicit and implicit curricula of schools but also what schools do not teach. It is my thesis that what schools do not teach may be as important as what they do teach. I argue this position because ignorance is not simply a neutral void; it has important effects on the kinds of options one is able to consider, the alternatives that one can examine, and the perspectives from which one can view a situation or problems (Eisner, 1994).

By omitting a topic or issue that is obviously connected (i.e., teaching cell theory...
and not discussing cloning) to science content, the students are being “dumbed-down” and shielded from developing compelling arguments related to the issues.

To shield a student from controversy is to shield him [or her] from the essential material of the analytical imagination, and to render him [her] incapable of rational independence, logical argument, or spiritual integrity, for none of these things can be achieved without fighting some terrible demons. (Werner, 1998, P. 117)

**Environmental Education**

Irving Berlin had no idea when he wrote “Heat Wave” that global warming would be an intense and fiery topic of debate in the political realm. The United States, reneged on its obligation to the Kyoto Protocol in 2000 based on “inconclusive scientific evidence” while approximately 2,000 world-renowned scientists reported that global warming *is* real and needs to be faced. It is the most requested topic for discussion upon arrival of new students to my environmental science course because of news reports, documentaries, and television special events centering on global warming.

According to one survey, more than 60 percent of undergraduate programs in environmental studies and/or sciences and almost 50 percent of the graduate programs started within the last 10 years (McGowan, 2004). McGowan (2004) continues citing a 2003 analysis which showed more than 1,000 environmental programs in existence at universities. Many of these are relatively small but do include membership in the Council of Environmental Deans and Directors (CEDD), an organization founded in 2001 that is dedicated to improving environmental education in U.S. colleges and universities.
McGowan (2004) believes environmental education has long been viewed as a means to reform science education. He states that environmental science is a way for non-science majors to boost their interest in science, get students out of the classroom, and demonstrate the links of science to politics, ethics, and social policy. I consider it to be the ultimate device for displaying the attributes of STS! In fact, Hodson (2003) believes the conception of STS should be broadened to include environmental education (STS becomes STSE). He states the definition of scientific literacy should include a degree of “political literacy.”

The content of environmental science programs, which require core science courses, and environmental studies programs, which focus on philosophy, vary amongst institutions. Some environmental programs focus on local issues of the region (e.g., logging or salmon fishing in Pacific Northwest, overdevelopment and beach erosion in the Southeast). Others cover environmental science from a global perspective. CEDD-affiliated programs teach environmental science and issues combine both natural and social sciences (McGowan, 2004). Hornig (1996) points that although undergraduate liberal arts colleges agree that environmental education should cross disciplines, promote problem solving, and holistic thinking, there is not enough concurrence on specific curricular components. He continues citing that some faculties have steadfastly refused to accept the environment as a suitable field of concentration.

McDonnell (2001) believes the long-term goal of environmental education
is to develop citizens that make choices and take actions based on an
internalized stewardship ethic. He notes the research design of stewardship
programs may be difficult to conduct due to the necessity for variable
manipulation (e.g., teacher training, curriculum materials, field experiences).
Hodson (2003) points that the authors of *Science for All Americans* (AAAS, 1989)
were directing attention toward scientific literacy for a more socially
compassionate and environmentally responsible democracy by indicating
“science can provide knowledge to develop effective solutions to it global and
local problems” and “can foster the kind of intelligent respect for nature that
should inform decisions on the uses of technology.” He regrets *Science for All
Americans* did not suggest that scientific literacy include the willingness to act in
environmentally responsible and socially just ways.

Some science educators, such as Hodson, believe environmental
education is the key to science literacy for the 21st century. He writes:

> Those without a basic understanding of the ways in which science
and technology are impacted by, and impact upon, the physical
and the sociopolitical environment will be effectively disempowered
and susceptible to being seriously misled in exercising their rights within
a democratic, technologically-dependent society. (Hodson, 2003, p.650)

Pointing toward university-based science educators in particular, Hodson
has outlined a proposal to broaden the conception of STS. He wishes to include
environmental education (naming it STSE) and extend the definition of scientific
literacy to encompass a measure of political literacy and the use of informal and
community-based learning opportunities. Hodson (2003) states we live in a
different world and science has lost its innocence and purity afforded by the creators of major curriculum advances of the 1960s. Hodson (2003) continues stating the succession of human and environmental tragedies have sometimes cast science in the role of the villain, where deep social changes and ethical concerns arise from scientific and technological innovations. He believes the increase in commercialization, industrialization, and militarization of science have shown once and for all that science is not value-free.

Kollmuss and Agyeman (2002) describe Chawla’s studies in environmental education concerning the life influences of professional environmentalists. Recollecting their formative years, most environmentalists describe having a predisposition toward nature and the environment based on childhood experiences and the pro-environmental values held by their families. Many participated in pro-environmental organizations and had teachers as role models. Actually, evaluating a student’s choice in career later in life (e.g., natural resources or environmental field), can provide a behavioral indicator of internalized environmental stewardship ethic (McDonnell, 2001).

Kollmuss and Agyeman (2002) cite Rajecki’s explanation at “explaining the gap” as a combination of four causes: 1) direct versus indirect experience, 2) normative influences, 3) temporal discrepancy, and attitude-behavior measurement. It has been shown that direct experiences concerning environmental problems (i.e., viewing a fish kill in a lake) show a stronger correlation of attitude toward behavior than indirect learning experiences (i.e.,
reading a case study in a book). Direct personal experience with people, objects, or events in a behavioral setting reduces ambiguity and increases the likelihood that expressions of attitude about a particular behavior will have predictive power (McDonnell, 2001). Social norms and cultural traditions of the dominant culture shape attitudes over time. Another factor related to attitude-behavior measurement relates to the actual questions, which may be broad in scope (i.e., Do you care about the environment?) versus the measured actions (i.e., Do you recycle?).

Another framework for analyzing pro-environmental behavior relates to models of altruism and empathy. Kollmuss and Agyeman (Kollmuss & Agyeman, 2002) cite Borden and Francis’s studies of altruism, hypothesizing that people with strong selfish and competitive orientation are less likely to act ecologically and opt to satisfy personal needs (e.g., time, money, energy). Those who have already satisfied their personal needs have more resources to participate in altruistic or pro-environmental issues. This hypothesis would make sense according to Maslow’s hierarchy of human needs, since studies have shown that poor countries rank environmental problems as being severe but their personal priorities may rank higher concerning immediate needs. Kollmuss and Agyeman (2002) describe several theories of caring and altruism that concur that self-esteem, belonging, personal control, and self-efficacy are necessary first before altruism may occur. In addition, awareness of people’s suffering encourages altruistic behavior. Schmitt et al (2000) cites Hoffman who proposed the
concept, stating that those who participate in civil rights movements or forms of activism may actually be members of privileged social classes, not a minority.

Cognitive Dissonance

Louis Armstrong may or may not have had a case of the “heebie jeebies” when he was scatting through his infamous song, but I feel I was “onto something” when I started learning about Festinger’s Theory of Cognitive Dissonance (Festinger, 1957) in graduate school. At that time I was developing an interest in altruism and Lerner’s “Belief in Just World” theory (Lerner, 1965), I was beginning to see educational research articles hinting at using “cognitive dissonance” as a motivator. Most of the articles centering on cognitive dissonance research were in the field of business, marketing, and nursing education. I felt its application in the use of controversial issues in science courses, particularly those related to STS, was a good fit.

Leon Festinger introduced the term “cognitive dissonance” as a substitute for “free association” and defined it as “feelings of unpleasantness” which an individual possesses lying deep in the unconscious, and where the individual seldom if ever realizes the reasons for such feelings (Chow, 2001; Festinger, 1957, 1964). More precisely, Festinger describes his theory in terms of consonance (balance) versus dissonance (imbalance) in reference to elements (knowledges [plural usage per Festinger]) about oneself or how one feels, wants or desires, what one is, and the like (Festinger, 1957). He refers to the term “knowledges” in its atypical usage of the word, for example, “opinions.” A person
does not hold an opinion unless he or she thinks it is correct, and so psychologically, it is the same as “knowledge.” The same holds true of beliefs, values, or attitudes, which function as “knowledges.”

Cognitive dissonance occurs in situations when new information becomes known to a person, creating at least a momentary dissonance with the existing knowledge, opinion, or cognition concerning behavior (Festinger, 1957; Misiti & Shrigley, 1994). Dissonance may arise from a logical inconsistency, cultural mores, a specific opinion, or past experiences. When dissonance occurs due to the presence of two elements in dissonance with one another, the magnitude of dissonance is based on the importance of the elements. In other words, if the conflicting elements hold value to a person, the degree of dissonance rises accordingly.

Thogersen (2004) states that not all inconsistencies are assumed to be equally disturbing, hence, different levels of cognitive dissonance likely occur. He continues stating that Festinger was not very precise in specifying possible sources of variation in the amount of dissonance produced by inconsistency, but later research has attempted to strengthen the theory on the point. One attempt by Aronson (1997) suggests that feelings of cognitive dissonance are tied to one’s self-concept. When one’s moral standards are being threatened or challenged, cognitive dissonance emerges. Hence, when a person is subjected to viewing or listening to information that contradicts heart-held beliefs, twinges to sharp spikes of dissonance could develop. Thus, in educational settings, the
exposure of students to controversial issues may provoke a dissonant response.

The theory of cognitive dissonance differentiates between degrees of dissonance based on an individual’s situation. Zimbardo (1969) cites that an 80-year old man who smokes may feel little dissonance about dying of lung cancer because he has lived a long, full life, even though he knows that “Smoking is related to lung cancer.” The issue is not important to the old man; hence, the degree of dissonance is reduced. A young college student hearing a lecture about Hiroshima and Nagasaki may feel minimal dissonance due to its historical nature and lack of personal relevance. The same student may feel twinges of dissonance listening to an article regarding birth defects caused by depleted uranium munitions since her/his best friend is stationed in Iraq. The thirty-something single mother in a college class may find great interest and concern knowing that the ill effects of “PFOA”, a suspected carcinogen in Teflon®, was known by Dupont for many years ("DuPont Denies EPA Charge of PFOA Cover-Up," 2004).

Upon hearing a company may have knowingly subjected humans to harm, a student may suffer cognitive dissonance based on the unfairness and injustice of the situation. This type of dissonance may relate to Lerner’s ‘belief in just world’ or BJW, which bestows the belief that life is justly fair (Lerner, 1965, 1980, 1997, 2003; Sallay & Dalbert, 2004). Those with high degrees of BJW feel that everything in life is predictable, controllable, and “what comes around, goes around.” Sallay and Dalbert (2004) cite that when people are confronted with an
injustice, either observed or experienced, their just-world belief is threatened. They are motivated to restore justice either psychologically (e.g., denial or reinterpretation of the event) or behaviorally (e.g., compensating the injustice). This concept is similar to those who strive for consonance when subjected to cognitive dissonance. On the flip side, those with high levels of BJW may “blame the victim” to justify the injustice and those with low levels of BJW may develop altruism when faced with the same injustice (Montada, Schmitt, & Dalbert, 1986; Sallay & Dalbert, 2004).

Aspects of BJW and cognitive dissonance may relate to environmental education. A study of fifth and sixth graders revealed that students actively contrasted the notion of rights versus societal laws, made utilitarian calculation of effects, and applied principles of justice when confronted with a local environmental dilemma (Pedretti, 1999). Using examples of dilemmas derived from current controversial issues (e.g., malathion spraying for mosquitoes, deep well wastewater injection, draining of Everglades) may be used to entice students into topical research and constructive debate. Integration of social justice with content learning provides a marriage between the application of STS in the classroom and the justice psychology of BJW. Through the use of discussion in the classroom, students may develop awareness of the ethics, moral implications, and complexities of real world issues.

The central assumption of cognitive dissonance is that human beings cannot tolerate inconsistency, and thus, try to eliminate or reduce it (Zimbardo &
Ebbesen, 1969). If something “does not sit well” with a person and dissonance occurs, a motivation within the person pushes its reduction through self-rationalization or overt demonstration against the dissonance (i.e., actions). Festinger (1957) describes the strength to reduce the dissonance as a state of drive or need, similar to the presence of hunger which leads one to reduce the hunger. The reduction of dissonance may be accomplished by several methods, depending upon the types of elements involved. The simplest action is to change a behavioral element (i.e., a person stops smoking after learning of its health effects), which may be difficult for some people and may even create a host of new elements in the process. Changing an environmental cognitive element may reduce the dissonance by bringing the cognition into consonance (e.g., avoidance of the dissonance element or associating with “like” people). By the addition of new cognitive elements into the schema, a proportion of the dissonance may be reduced (i.e., a smoker reading research material listing the increased death risk of automobile driving versus smoking).

Although the inclination of a person with cognitive dissonance is to reduce the magnitude of the dissonance, this may not always happen. A person may find the social support needed to reduce it, but it is possible the dissonance may actually increase in strength. It will depend upon what the person encounters during the attempt to reduce the dissonance. Personality differences of individuals, life experiences, and innate values may determine if avoidance or perhaps confrontation will occur when confronted with dissonance.
Cognitive dissonance arousal has been empirically substantiated in extensive indirect and direct studies (Cooper & Fazio, 1984; Elliot & Devine, 1994). The few studies performed on cognitive dissonance arousal used direct self-report measure and showed an unequivocal demonstration of the psychological aversion of dissonance. Thus, the phenomenological experience of cognitive dissonance appears to be a distinct, aversive feeling, not an undifferentiated arousal state (Elliot & Devine, 1994).

By exposing students to controversial issues in the classroom, feelings of dissonance may erupt. When students are exposed to alternative perceptions and conflicting views, creating a state of cognitive imbalance, they are motivated to continue the discussion to resolve the cognitive conflict (King, 2002). Interactions with their peers require students to confront any differences in each other’s current understanding of the topic as well as their differing attitudes or perspectives. However, through explaining and defending their views, the conflicts may be reconciled through this social construction of knowledge. King (2002) believes that high-level cognitive processing involves making inferences, drawing conclusions, synthesizing ideas, generating hypotheses, comparing and contrasting, finding and articulating problems, analyzing and evaluating alternatives, and more. Furthermore, cognitive dissonance could possibly be the catalyst to high-level cognitive processing.

*Reflective Thinking*

When Bessie Smith sang “Thinking Blues” in 1928, she probably was not
contemplating “Reflective Thinking” at the time, but it was around that period that John Dewey was considering “How We Think.” Dewey (1933) defines reflective thought as active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends. He continues stating

reflection implies that something is believed in or disbelieved in, not on its own direct account, but through something else which stands as witness, evidence, proof, voucher, or warrant, that is, as a ground of belief. (Dewey, 1933, p. 8)

King and Kitchener (2004) may have been inspired by Dewey’s works (1933) when they developed the Reflective Judgment Model (RJM). Dewey described how reflective judgments are created upon encountering controversial arguments or doubts when logic alone does not contribute to the reasoning of the dilemma. It is widely accepted that an individual’s personal beliefs contribute substantially to epistemological cognition, in resolving issues via one’s individual thought processes (Schommer-Aikins & Hutter, 2002).

During the last 25 years, Kitchener and King have further examined RJM in late adolescent and adult development, largely basing their rationale on the cognitive-development theories of Piaget and Kohlberg. Both theorists share the commonly held approaches that presume the following: 1) underlying assumptions that meanings are constructed; 2) the emphasis on understanding how individuals make meaning of their experiences; and 3) the assumption that development occurs as people interact with their environments (King & Kitchener, 2004). In addition, it is speculated that as cognitive development
progresses, the organizational interpretation of events becomes more integrated and complex.

Kitchener and King developed their seven (7) stage model, which is grouped into three levels: pre-reflective thinking (Stages 1—3), quasi-reflective thinking (4—5), and reflective thinking (Stages 6—7). As one encounters a controversial dilemma, a person assumes the levels as follows:

♦ Pre-reflective thinking—The person assumes that the knowledge is correct based on beliefs, including the absence of evidence or an opinion of an authority figure.

♦ Quasi-reflective thinking—The person recognizes uncertainty in the knowing process and that knowledge is *internally* constructed, not simply dictated by authority.

♦ Reflective thinking—The person weighs evidence, develops interpretations based on reasonable evaluation of various perspectives, and concludes a position. As new evidence arises, the information may be evaluated, altering the current argument.

The field of science education is ripe for stimulating young adults through exposure to dilemmas in science and bioethics. Topics such as embryonic stem cell research or medical marijuana usage provide fodder for students to ponder, contemplate, and debate. Since many young adults are close to voting age, familiarity with value-laden complex issues is imperative to produce an informed, democratic citizen. Students can filter through the science facts and construct
Kitchener and King (2004) describe the study performed by Wood, Kitchener and Jensen that examined 8,537 students enrolled in college, graduate, and professional programs at seven different colleges and universities. While controlling for academic aptitude and prior academic achievement, graduate students scored significantly higher than medical students, whom scored significantly higher than undergraduate students (p<.001). It is interesting that the medical students fared in the middle because they likely will encounter controversial and ethical issues in their profession. It is a possibility that the fact-based nature of biology and anatomy and physiology may predispose the students toward memorization, without encouraging reflective reasoning. This has been a complaint of those who view science as a collection of facts and theories, rather than an integration of content with societal undertones.

Friedman (2004) performed a study of the relationship between reflective judgment and personality traits. When a person encounters a controversial dilemma, the degree of reflective reasoning may be dependent upon certain personality traits within the individual. Friedman’s study hypothesized that six of 14 traits would be significantly associated with reflective reasoning and intellectual disposition, as follows: thinking introversion, theoretical orientation, estheticism, complexity, religious orientation, and autonomy. Contrarily, the remaining eight traits were hypothesized to be irrelevant to reflective reasoning, including the following: social extroversion, impulse expression, personal
integration, anxiety level, altruism, practical outlook, masculinity-femininity, and response bias. The sampling pool consisted of 91 undergraduate, graduate, and doctoral students enrolled in a private Catholic institution.

The results of Freidman’s study showed four of the six hypothesized traits to be associated with intellectual disposition: thinking introversion, autonomy, theoretical orientation, and complexity (Friedman, 2004). Contrary to the original hypothesis, the author’s definition of intellectual disposition was lacking significance in two areas: estheticism and religiosity. Actually, the insignificance of religiosity appears reasonable because those guided by religion likely adhere to authoritarian viewpoints, without producing reflective thinking. Two additional personality traits not previously considered were correlated with scores as follows: response bias and altruism.

The result of altruism appears to be particularly interesting because it implies that a person who is capable of high reflective judgment may harbor a global perspective; empathy toward social service, and sensitivity toward humanity. Freidman (2004) believes that experiences such as participating in community service activities, student government, or the Peace Corps not only enhances understanding of other perspectives, but encourages self-transcendence, expansion of social radius, and acknowledgment of universal truths. While participating in these types of activities, people may encounter human suffering, injustices, and social dilemmas, often which require empathy, tolerance, and sensitivity. High level reflective thinking appears to fit into the
framework created by altruism.

Freidman (2004) concluded that reflective persons actively solve dilemmas in real life, assimilate new learning, and modify previously held belief systems. Cultural, social, and historical experiences impact the complexity of the dimension, requiring an open-minded outlook to develop reflective judgment. The profound meaning underlying Freidman’s research is best said in the following:

Knowing for the sake of knowing, being predisposed to knowing, or knowing how to know, may have little real value in life where acting upon a belief system is what impacts societal change. (Friedman, 2004, p. 303)

Karjanne (2003) evaluated the relationship between reflective judgment and laypeople’s viewpoints through interviewing 59 Finnish adults (1986—1988) and following-up 1993—1994. The participants consisted of people working in all professions and the ages ranged between 24 and 50 years at the follow-up time (only three participants refused to rejoin the study). Kitchener and King’s RJI was administered using the food additive dilemma from the original studies. He had hoped to determine a connection between reflective judgment and the dilemma, determine if educational level plays a role in reflective judgment, and if there are indicators at particular stages of reflective judgment.

Since reflective judgment development coincides with young adulthood and entry into higher education, this may be a difficult time in students’ lives. Students in today’s society may encounter ethnic and social diversity, sexual situations, and difficult life choices. Educators can assist students in acquiring
and possibly mastering skills associated with complex thinking, coaxing the students into higher reflective stages in the process.

Guthrie’s (1997) research on tolerance for diversity among college students suggests that tolerance requires a base level of intellectual development, specifically, reflective judgment ability. She continues that although moral and intellectual developments are related domains, the experiences that affect each progression may vary. Guthrie continues citing Kitchener and King’s belief that ill-structured problems in the moral domain concern making decisions about social values, especially about “how humans ought to act in particular situations.” Moral dilemmas that college students may encounter may touch value systems and intellect, involving epistemological issues. Decisions and solutions may require constructing information that may be gapped or incomplete, making assumptions in the process. Various perspectives and opinions may be contemplated to assemble a reasonable conclusion the student can reasonably tolerate. Although tolerance or nonprejudice responses are related to intellectual development, reflective thinkers tend to be less influenced by outside opinions (e.g., parents, society, and religion). Guthrie did note that intellectual development does not completely predict tolerance, which is consistent with Devine’s model of prejudice (Devine, 1989). The level of moral sensitivity and emotional response may not be fully developed in college students and they may not be aware of their innate bias and stereotyping unless an educator draws attention to the situation through the use of moral dilemmas.
This is definitely a benefit for the use of controversial issues in the science classroom.

According to the RJM studies, maturity plays an integral role in the development of reflective thinking. Friedman’s study of personality traits showed that RJI was associated with an introspective, independent-minded, abstract thinking individual. Science encourages methodical, logical sorting of facts and positive skepticism. Tolerance of welcoming new developments in science may alter or enhance a theory, creating dissonance among young adults who only see in “black and white” terms. Young adults need to be encouraged to question the facts and create solutions based on sound assumptions. These critical response skills can be learned and with practice can become a lifelong habit of mind (AAAS, 1989).

Reflective Writing

Even Johnny Mercer may agree “What could be a better way to reflect than writing?” If John Dewey were alive, he would be a likely proponent of reflective writing, since the elements are indicated in his work. Reflective writing critically evaluates and develops personal judgments for the purpose of applying the analysis to future action and goals (Josefson, 2005). Seeking the truth through this self-analytical process is the goal. Josefson (2005) suggests five stages of reflection: 1) exploration, 2) explanation, 3) conjecture, 4) analysis and 5) synthesis. The stages are further explained as follows:
• The exploration stage requires students to explicitly state his/her prejudgments or beliefs held about a particular issue *up front* so they can be held up to critical examination.

• The explanation stage requires students to engage in comparison/contrast and clarify the concepts of the “perplexity or disequilibria,” as Dewey would say.

• The conjecture stage requires students to formulate a question that might help them resolve or at least further explore the tensions created.

• The analysis stage requires students to “connect the dots” by bringing forth a position as opposed to arguing for a position.

• The synthesis stage requires students to draw out the implications of their analysis (Josefson, 2005).

  Reflective writing for college students assists in self-discovery and self-analysis. I have observed my environmental students’ term papers and short opinion pieces with much interest and intrigue. Students appear to naturally want to “be heard” and participate in a running online dialogue with me. Some students email personal questions concerning their home life, “How do I get rid of the fruit rats in my trees without hurting the environment?” One student wrote a paper about the “Effects of the Human Papilloma Virus” and later confessed to me that she was recently diagnosed with it. She is glad her baby born a few months ago was via C-section. I recall how another student wrote that she prompted her father to recycle scrap wood and build a fence to
hide her trash container. This was a father-daughter weekend project she was inspired to do after the lecture on recycling. Even if the students are not mature or experienced enough to create a well-constructed reflective essay, their application of classroom knowledge and self-expression is refreshing.

*Explicit Memory and Emotion*

Scientists are making discoveries in regard to intentional and incidental learning. According to Steven Petersen, neuropsychologist, most of what we remember from our everyday life we have learned incidentally (D'Arcangelo, 2000). We are bombarded from birth to adulthood with overwhelming amounts of information, experiences, and memories. We *remember* information in our lives that mean the *most* to us and it normally requires little effort. According to Petersen, hundreds of studies in the cognitive psychological literature show, in most cases, incidental learning is as good as—and in some cases better than—intentional learning (D'Arcangelo, 2000). He continues

> If you compare a situation in which people are asked to remember a list of words with a situation in which people are asked to tell you what the words mean to them and how much they like those words, the latter group will remember the list of words just as well even though they haven’t been intentional trying to remember them. (D’Arcangelo, 2000, p. 70)

The interview with Steven Petersen is especially interesting in regard to environmental education. In environmental courses, students are exposed to an integration of science content within a social context, unlike straight single-subject science courses. When controversial issues are tossed into the mixture, the kettle becomes a minestrone of environmental topics. Students will likely
consume, sample, and devour what has value to them. The question becomes, “What has value to the students in an environmental science college course?”

_Every time I cook, look like you can’t get enough_  
_Fix you a pot of soup and make you drink it up_  
_So keep on a-eating_  
_Oh, keep on a-eating_  
_Keep on eating, baby, till you get enough._ (Memphis Minnie)

Petersen discusses how emotion can be used to direct attention in the classroom, leading to better learning (D'Arcangelo, 2000). If students are uninvolved and unmotivated in an explicit learning situation, learning will likely not be achieved. However, if an instructor can get the students emotionally charged, they can possibly rise beyond the effective level (D'Arcangelo, 2000). Reading these statements from Petersen provides powerful support for the benefits of stimulating cognitive dissonance in students through discussions of controversial issues in the science classroom. The controversial issues may be the impetus to drive the emotion to promote both incidental and explicit learning. Petersen believes slight stressful situations in a learning environment are better than an absolutely neutral state (D'Arcangelo, 2000).

It is well documented that emotion enhances explicit memory for material that encompasses personal autobiographical, picture, and word-based items (Dolan, 2002). Name recognition is enhanced by the input of emotion. Psychological evidence shows emotion as an affect on episodic memory function, indicating influences on hippocampal function and most probably extra-amygdala regions (Dolan, 2002). For these reasons, there appears to be
physiological and psychological support for the use of controversial issues in the classroom. Controversial or value-laden issues may create feelings between a pang and a mild disturbance (dissonance), depending on its emotional context of the individual. As shown, these emotional reactions may enhance memory or word associations according to their value for students.

So whether Frank Sinatra is “Learnin' the Blues” or teaching the blues, emotionally-laden material stays with a person long after the song is over. It is the personal relevance or resurfacing of memories from indicator tags that entrenches a sullen song…or a memorable college lecture.

**Traditional vs. Non-Traditional Age Students**

For the last year, I have been teaching environmental science to non-science majors at a small private college. Students enrolled in the liberal arts programs typically earn a two-year degree, but some do further strive and earn a four-year degree. Other trends worth noting: more students attend college part-time than in previous years; a higher proportion of students are women; and more students are over age 25 (Oblinger, 2003). I personally have observed the diversity in age ranges and reasons for pursuing higher education. From my experience in the college classroom, there appears to be a large group of students who are traditionally-aged college students, between 18 and 22 years old. They are likely single, employed and may or may not live at home. There appears to be a group of female students in their late twenties to mid-thirties, single mothers, and who may still be living at home with family or their “baby’s
father.” There appears to be a group of divorced, working men and women in their late thirties to early fifties who are pursuing a college degree to raise their economic status. I have observed a group of men in their mid-thirties to late forties who are either ex-military or who have been unemployed for some time and in need of a fresh career path. With this diversity, a college instructor must be able to reach and touch the students who obviously bring to the table various experiences and needs. What are their attitudes, strengths, and weaknesses? Who are these students?

There are three generations which represent students enrolled in college today: Baby Boomers (born between 1943 and 1963); Generation X (born 1964 to 1980), and Millennials (1981 to present). Journal articles differ on the definitive birth date range of the Baby Boomers, but for this paper, the birth date range will stand. I was born in 1962 and identify more with Baby Boomers than Generation X’ers likely due to my upbringing. I was raised by two liberal leaning Baby Boomers who were very much into the pop culture and shared the values of the era. Also, it is not an accident that my focus in generational influences emerged in my dissertation. My Master’s thesis “The Influence of Risk Communication on Environmental Perceptions” delved heavily into the topic, so my current work is an extension of a long time interest.

In their book Generations, Neil Howe and William Strauss (1991) define their generational model as a theory of social history that describes and explains changes in public attitudes. Howe and Strauss believe that a person’s value
system is created during the first 10 years of life. Any significant historical or life events during these years instill the societal values, which are carried with the person throughout his or her life. People who were reared during similar historical years often experience these events. With this in mind, a life cycle occurs approximately every 20 years, with the onset of the next generation. As a generation matures from youth to young adult, middle life, and senior years, the generational attitudes evolve to a different societal role.

**Baby Boomers.** Offspring of the Silent Generation (those born between 1925 and 1942) became known as the Baby Boomer generation. Baby Boomers came of age in the 1960s, a turbulent and socially revolutionary decade in the history of the United States. Political upheaval, anti-war protests, and breaks from tradition marked the turning point of social culture and values. Disillusionment with “the system” included corporate hierarchy, authority figures, and the U.S. government. Young people’s beliefs, hopes, and dreams of a better United States were shattered with the assassination of President John F. Kennedy. Americans watched in disbelief as the grisly scene replayed on national television. Other assassinations soon followed those who supported civil rights, such as Senator Robert Kennedy and Dr. Martin Luther King, Jr. After theories of government conspiracies overshadowed these tragedies, the American people became distrustful. In 1967, racially motivated violence broke out in Los Angeles and Detroit demonstrating further unrest. Additional disillusionment with the American government prevailed due to the United States involvement in the
Vietnam conflict. The unpopularity of the war, which seemed senseless and futile, prompted student protests and demonstrations. Students openly criticized the U.S. government and spouted anti-war demonstrations on national news. Students rebelled against university administrations, government officials, and denounced authority figures through activism. The 1960s appeared to be a decade of violence and unrest, which saddened the complacent Silent Generation. The Baby Boomer generation questioned authority, in contrast to the elders of the Silent Generation. Instead of being drafted to Vietnam, many young men pursued multiple college degrees or fled to Canada (Tabone, 2002).

The 1960s marked a decade of revolt of traditional values and welcomed a journey of self-exploration and individualism. Young American men and women abandoned their modest proper dress in favor of unkempt, tattered clothing. Men opted for long hair, beards and mustaches, in contrast to the 1950s clean shaven “Leave it to Beaver” look. Women, in the spirit of their newfound feminism sported pants, long hair, scarce makeup, and no bras. In addition, women began reentering the work force and demanded equal pay. With two parents working, children of the Baby Boomers became “latch key” kids. In the 1960s, after the advent of the birth control pill, young Americans found a new sexual freedom, in contrast to the repressed Silent Generation. Morality took a new twist as couples engaged in premarital sex and lived together. Young adults discovered the freedom of self-discovery and introspection by exploring religions outside of traditional Christianity. Interest grew in the areas of Transcendental Meditation,
mysticism, New Age, and even fundamentalist Christianity (Tabone, 2002).

The 1960s marked a “back to nature” theme with the birth of environmentalism. Concern for Mother Earth became the nation’s pastime. A movement toward “natural” food products emerged. Not only did Baby Boomers sink back into earthly comforts but also they reached to the heavens. In 1969, when man walked on the moon, a new space frontier and age of technology was launched.

As the 1970’s arrived, Baby Boomers felt an even deeper disillusionment with the government as the Watergate Scandal (1973) emerged. The morale of the country reached a new low as President Richard Nixon was impeached. The 1970’s highlighted the downfall of the economy into a recession, when inflation rose dramatically, creating inflated prices. Abandonment of employer loyalty became the mode of self-promotion. Americans began seeking better employment and pay by “job hopping” (Tabone, 2002).

Baby Boomers married and had children at a later age than the previous generations. In the 1970s, the divorce rate rose, creating single-parent households for childrearing. Surrogate families were created as divorced parents remarried and had children. Some blame the increase in the divorce rate due to the sexual revolution, loss of family values, and narcissistic mid-life. Baby Boomers started to think about themselves and did not stay in relationships for “the sake of the children.”

In the 1980s, as the economy improved, Baby Boomers began searching for
the “American Dream” through living the “yuppie” lifestyle. As narcissism increased, the Baby Boomers felt they should be rewarded for their years of hard work. As the computer age created higher technology, the Baby Boomers purchased all the latest gadgets and crazes. The spending spree continued through the 1990’s, as the unemployment rate was at its lowest since the before the Vietnam War. To maintain the living style, Baby Boomers resorted to credit cards and borrowing, creating a greater debt load in contrast to previous generations (Tabone, 2002).

With the coming of the Millennium, the moral fiber of the American public took on two extremes—ultra liberal to extremely conservative. Topics that were taboo to the Silent Generation are openly discussed by the American public and shown in the media. Toward the end of the 21st century, the “Moral Majority” gained political power, attempting to persuade the American people to their views through legislation.

Generation X. The Generation X’ers, who are children of the Baby Boomers, were born in a period of slow birth growth, between 1965 and 1975. These years reflect the core group of Generation X. The single lowest birth year in U.S. history was 1975 (Strauss & Howe, 1991).

The Generation X’ers have been widely criticized as being the “slacker generation.” With the fluctuation of the economy, Generation X has contended with corporate downsizing, stock market crashes and lack of faith in politicians. Most of the Generation X’ers seek education in fields which guarantee monetary
rewards. Company loyalty is non-existent, as well as the lack of job security provided by employers. Generation X’ers have been subjected to so much risk of violence, abuse, HIV, and drugs at an early age, that acceptance as a “fact of life” has become the norm. Unlike the Baby Boomers who grew up in innocence, there is no safe and secure world to the Generation X’er. Even the family life is insecure with a large portion of the population growing up in broken families.

By the year 1990, families with working mothers became the norm. Children were being raised by day cares and received little of the traditional family life as parents worked harder and longer hours. Guilty due to the lack of time and attention, parents often lavished children with material belongings, without teaching the value to money. Generation X’ers grow into adulthood, expecting material rewards for work, and not for the intrinsic value (Tabone, 2002).

Since the Generation X inherited economical recessions and inflation, many do not leave home at adulthood. Some may find themselves moving “back to the nest” after marriages fail. The Baby Boomer grandparents, who are approaching retirement, raise the grandchildren.

Politically, Generation X’ers are known as noncommittal and lean toward pragmatism. Many have been accused of apathy and no interest in politics or voting. The attitude of most Generation X’ers is “why bother….what’s in it for me?” or “Whatever?” The Generation X lives for today and not the future, feeling life is an uphill battle. Most feel they will have to work until death since the promise of economical rewards and the benefit of Social Security is bleak
The Generation X’ers have experienced growth spurts of technology, as the world entered the computer age. They are comfortable with computers and are open-minded to technological advancements. Some have achieved wealth through Internet-related businesses. The Internet has marked an important place in a Generation X’ers life, as it may serve as a source of information and social life for the self-absorbed.

According to Howe and Strauss (2000), the Generation X’ers have not known war (with the exception of the Gulf War Conflict). Their book was written prior to the “events of 9-11”, which may show a very different story. Howe and Strauss list the Challenger explosion and the Oklahoma Bombing as climactic events for Generation X.

**Millennials.** This Millennial Generation, as described by Howe and Strauss (2000), were raised with Gameboys®, the Internet, cellular phones, and *i-pods®, and are adept at following directions. They are driven by parental micro-management as their schedules, needs, and social lives are prepared for them. Authority figures play a prominent role in molding their thinking patterns as creative skepticism is stifled. Millennials have come to trust and count on authority, leading them to a sheltered existence. They are encouraged to follow rules and not “buck the system,” although most find it acceptable to cheat and plagiarize in this age of technological savvy and access to information (DeBard, 2004; Howe & Strauss, 2000; Wilson, 2004). Millennials are believed to be more
politically conservative, while holding liberal attitudes toward social issues (Wilson, 2004). They are known to be very team-oriented and desire cooperation, structured learning, and oppose risk taking (Howe & Strauss, 2000; Oblinger, 2003). Highly conventional, one of the great challenges to Millennial students in college is to navigate the turbulent waters of divergent values practices and espoused by those who do not share their characteristics (Lancaster & Stillman, 2002). Oblinger (2003) sums up the characteristics of Millennials as follows:

- gravitate toward group activity;
- identify with their parents’ values and feel close to their parents;
- spend more time doing homework and housework and less time watching TV;
- believe “it’s cool to be smart”;
- are fascinated by new technologies;
- are racially and ethnically diverse; and
- often (one in five) have at least one immigrant parent.

Seventy-six million strong at the end of 2000, this generation shares a lot of unique qualities over the previous generations (Howe & Strauss, 2000). Millennials are more affluent than previous generations due to parental allowances. Parents have told this generation “they are special” so confidence is a trademark. Howe and Strauss (2000) describe the Millennials as looking polite, well-behaved, and clean-cut, yet they are probably the most tattooed and pierced generation I can recall!

According to Howe & Strauss (2000), most Millennials are far more trusting
than their parents concerning the capacity of large national institutions to “do the right thing” on the nation’s behalf. Higher trust in government officials may contribute to lower cynicism and may actually reduce voter participation (Blackhurst & Foster, 2003). While they do not feel their civics classes are particularly important, they more likely than adults (50 to 26 percent) trust the government (Howe & Strauss, 2000). When teens are asked who is going to clean up the environment, cut the crime rate, and solve world problems, they point to “teachers, government, and police.”

Blackhurst and Foster (2003) examined community volunteerism and political involvement of college students since Howe and Strauss (2000) had noted community service was popular with the Millennials. The percentage of students who reported participating in community service projects (71.3% in 1996 and 67.5% in 2000) was comparable to the voting reported in the 1996 and 2000 elections (Blackhurst & Foster, 2003). The researchers believed the relatively high percentage of voting for those between 18 and 24 years predicts later political involvement. Blackhurst and Foster (2003) concluded Millennials who did not vote were significantly more apathetic, cynical, and less optimistic than voters. There was a significant correlation (p=.0001) between students’ attitudes and both their political commitment and service involvement.

After reading in journal articles about the rise in volunteerism among the Millennials, I decided to ask a local college student for his opinion. He is a junior majoring in political science, a former Eagle Scout, and is currently interning with
a local Congressional candidate. I asked him “What provokes your generation to participate in so much volunteerism?” He simply replied, “It’s not by choice. If you want to get a scholarship or get into a good school, you have to do community service to beef up the resume.” So, after reading books by Howe and Strauss, I wonder if they are really in touch with the Millennials?

Most Millennials have been sheltered by their doting parents, who have organized their social lives (e.g., soccer practice, parties, “play dates”) and pushed their children into achievement (e.g., Sylvan Learning Centers, private tutors). Achievement for this generation is at an all time high (DeBard, 2004; Howe & Strauss, 2000; Strauss & Howe, 1991). Yet with all this confidence and support, the Millennials are also the generation was raised with Prozac and Ritalin!

For the next 20 years, colleges and universities will be contending with Millennials and their needs: the need for order and organization, computer and technological savvy, and yearning for teamwork. Adjustments will need to be made to reach these students as well as the mix of Generation X’ers and Baby Boomers enrolled in the system. As cumbersome or overwhelming as it may seem to accommodate all of the generations, we need to listen to Johnny Mercer’s advice and “ac-cent-tchu-ate the positive.”

Summary

Science education reform, which has been mandated in K-12 schools, is not pervasive in higher education. A non-science major may be introduced to
science through a sole course, limiting the undergraduate science student’s ability to act as a scientific literate citizen. A non-science major’s attitude toward science may be created or destroyed based on his or her experience.

The introduction of controversial issues into an introductory science course, particularly environmental science, may promote cognitive dissonance, which serves as a motivator towards student interest and serve as a path toward reflective thinking. Discussion of emotionally charged issues in environmental science may increase memory and enhance learning (D'Arcangelo, 2000).

An increase of traditional and non-traditional aged students in higher education has been observed. It is the goal in higher education to reach all students in spite of generational differences. For this reason, the embedding of controversial issues in the curriculum as well as other science education reform techniques may enhance multigenerational learning.
Chapter Three—Methods Used in this Study

Introduction

Having performed traditional quantitative research and mixed methods in the past, I found the qualitative portion of my studies demonstrated the most interesting findings. The nuances and anomalies created intrigue and provoked further questioning. Like jazz improvisation, you never know which note is next! Reflecting upon my Master’s thesis, the quantitative approach of measuring with an “instrument” to generate knowledge felt contrived. The data did not flow freely from the participants. They were forced through the pre-determined question slots provided on a survey form. The free-flowing essay portion of the survey yielded fascinating results.

Phenomenological Framework

The nuts-and-bolts of my research study included reviewing literature on qualitative methods and asking, “What is the best method to answer my research question?” The purpose of my study was to describe and explain the ways non-science majors in an undergraduate environmental science course respond to controversial issues embedded in the curriculum of a course consistent with the science reform movement. What I realized is that both the students and I were undergoing the experience together.

Creswell (1998) states a phenomenological study describes the meaning
of the lived experiences for several individuals that encounter a concept or phenomenon. Probing deeper into the meaning of phenomenology, its aim appears to describe phenomena rather than create explanation (Ehrich, 1996). The descriptions must be as one undergoes the human experience, digging deeply into one’s self. Based on students’ living the experience of controversial issues embedded in the 12-week course, a phenomenological approach appeared to be appropriate.

Phenomenological studies ask subjects to write descriptions of a situation experienced in a particular phenomenon, in-depth interviews, or case study analysis (Ehrich, 1996). Data are collected in two key ways: focusing on the participants’ experiences (using interviews without actually experiencing the phenomenon) or the researcher’s experience in the phenomenon as an observant of participants (Bogdan & Taylor, 1975; Patton, 2002). According to Patton, either approach is legitimate for a phenomenological study.

The phenomenological approach to data analysis involves four steps: description, extraction, transformation, and synthesis.

- The searcher first reads all descriptions in their entirety. These narratives describe the human experience and consciousness of the participants in the study.
- The researcher extracts significant statements or meaning units’ from each description.
- These statements are formulated into meanings, and these meanings are clustered into themes.
- The researcher integrates these themes into narrative
Ehrich (1996) further describes the final stage of synthesis as important because the researcher moves from specific structural descriptions to recognizing general commonalities across the sample of subjects’ experience of the phenomena (i.e., theme). She continues stating

an assumption within phenomenological studies is that individuals are unique and have unique experiences, phenomenological studies also emphasize an examination of the experiences of a number of subjects so the essences or essential structures can emerge. (Ehrich, 1996, p. 205)

Description of Participants and Location of Study

For the last year, I have been teaching an environmental science course which is required for all non-science majors enrolled in liberal arts programs at the college. Each class normally consists of 25 to 40 students, depending upon the time of day or number of sections offered. The undergraduate majors include the following: accounting, business management, medical billing, paralegal studies, computers, and criminology. The students at the college earn either an Associate’s or Bachelor’s degree.

The students enrolled in the course appear to be traditional college-age students (late teens to early twenties) and non-traditional age students (thirties thru fifties). All of the students are legally adults. My past teaching experience indicated the composition of classes generally as follows: 42 percent (Millennials), 42 percent (Generation X’ers) and Baby Boomers (16 percent).
There are normally 60 percent females and 40 percent males enrolled in the course.

Students practice various lifestyles (e.g., gay, single-parent, living at home, etc.), socioeconomic statuses (e.g., middle-income, low-income), employment statuses (e.g., employed, unemployed, ex-military), and ethnicities (e.g., Caucasian, Asian, African-American, and mixed races). A large portion receives Federal assistance for both school tuition and living expenses.

The college is located in a suburb of a metropolitan city (approximately 2.4 million people) in southeastern United States. The area is considered to be multi-cultural in composition, with student ethnicities including Asian, Croatian, Caribbean, Middle Eastern, and African.

Description of the Course and Activities

After answering an advertisement in the newspaper for an “Environmental Instructor,” I began teaching in spring 2005. The school requires students in each major field of study to enroll in a four-credit science course. I was given a Prentice-Hall textbook entitled *Environmental Science toward a Sustainable Future* and a general syllabus format. Keeping the quarter system (one four-hour class for each of 12 weeks) in mind, I was asked to design the course as I saw fit. The design includes grading, lecture methods, topics, field trip options, test design, assessment methods, demonstrations, and use of in-class media. A copy of the syllabus is included in Appendix A.

The college does not use Blackboard or any equivalent website-based
tool. As a courtesy, I email students Power Point presentations in advance of each lecture, course announcements, and links to interesting environmental articles. I encourage communication via email and require that every student obtain an email address.

I devote the first 45 minutes of class instruction to oral readings of newspaper clippings concerning current environmental science articles and political news related to environmental science. I always list the source of the articles and often provide the title and author so students may verify authenticity.

Students are provided with an open forum to discuss the introduced issues. I act as moderator and ask probing questions to keep the dialogue flowing. I emphasize bioethical issues related to human experimentation, especially controversial science practices used in the United States during the past 70 years. Research into science atrocities and breaches of bioethics has become a pet project. Current political controversial issues discussed in the course include the following: mining limestone in the Everglades, logging in national forests, drilling for oil in the Gulf of Mexico and Alaska, depleted uranium and white phosphorus weapons in Iraq, Gulf War Syndrome, Hurricane Katrina and its aftermath, pesticide testing on children in Jacksonville, the Teflon® controversy, and the bombing of Hiroshima and Nagasaki.

During the course, I share personal stories of bioethical issues regarding the environment. One unique scenario I describe to the students is called the “Stuckey’s dilemma.” I describe to the class my personal experience with a site
that had a benzene-contaminated potable well that the government agency refused to treat with activated carbon. The water is consumed by low-income families who live in converted apartments at the back of the former Stuckey’s. In addition, the water is used by the restaurant/grille for public consumption. I tell the students about my experiences in other whistleblower cases, such as my work with EPA and Department of Agriculture to uncover a mold scam conglomerate. In addition, I tell how I obtained “classified” information from the CIA concerning military experimentations (e.g., release of whooping cough and yellow fever mosquitoes into the environment for tracking studies) performed in the 1950s in our local community.

I normally introduce the same news articles every quarter to coincide with a planned lecture. During the summer quarter, small deviations based on “hot” topics of the week slightly altered the mix. I offer articles to the class as handouts on topics such as composting, the environmental voting records of House and Senate representatives, and global warming. A schedule and list of the articles discussed during the lectures each school quarter are presented in Appendix B.

Most of the science content is delivered through the Power Point presentations that were included in the Prentice-Hall textbook. I added original slides and photographs to expand topics. For example, I show slides of my environmental field excursions to show how scientists work in “real life.” I deliver a traditional board lecture for one chapter on ecology and natural selection to
provide a contrast.

Short video presentations from *National Geographic*, the PBS series *NOW*, and even John Stewart’s *The Daily Show*, provide hard factual science mixed with a bit of humor. In addition, prior to the field trip to the reclaimed water facility, I share a cartoon provided by the utility company.

Students are divided into groups of four to participate in activities centered on recycling plastics, hazardous waste in the home, and a hypothetical environmental management case called “Clear Lake.” The “Clear Lake” activity occurs during the last class before the final exam because it ties together the entire quarter. Each group of students determines where to place a particular item (e.g., pine bundling industry, well field, environmental science center, cattle farm, picnic area, and sinkhole) in relation to the lake.

I perform a “sinkhole” demonstration which gives students a fun, yet serious, perspective on how sinkholes are created. I create a model of a sinkhole using soil from my backyard, purchased silica sand, sugar cubes, a ceramic Victorian house, a large clear plastic container, and a pitcher of warm water (Tabone & Keen-Rocha, 2004). As a student volunteer mimics rainfall by pouring warm water in intervals onto the ceramic house, the house slowly sinks and tilts to one side. Although simplistic in design, it is a visual recreation of how a sinkhole is formed and a surface structure reacts.

During the school quarter, I offer the opportunity for a field trip to a reclaimed water facility. Students are encouraged to bring a family member,
spouse, significant other, friend, or teenage child along on the Saturday outing. The facility provides classroom instruction and a tram-tour of the operations and various sewage treatment stations (e.g., clarifiers, gratings, fertilizer building). The facility uses anaerobic digestion to produce methane for heat-treating sludge to create fertilizer. There is a river alongside the facility with numerous birdlife, creating a unique experience.

I have a strong belief in experiential education and felt the field trip was essential to the college course experience. Even though the field trips are optional and extra credit are given to those who attended, I ask the students, “Do you remember taking field trips as a child? Where did you go and how old were you?”

Many students remember going to a museum, zoo, or science center when they were in elementary school, possibly 30 to 40 years ago! My thinking is if the trip made an impression on them as a child, then a family-bonding experience as an adult is definitely worthwhile.

Grading Requirements

The students receive grading credit for the following: attendance and participation; two term papers; weekly homework assignments, reaction papers, and a cumulative final exam. The weekly homework questions are a combination of original questions and assigned textbook questions. The answers are discussed during the following class and credit (not in a grade form) is given. Letter grades are given for the term papers and final exam. Penalties are applied
to late term papers. Students are required to produce a reaction paper every week. If the student provides a weekly paper (at least 10 papers), he or she receives the required credit plus extra points. Extra credit is given for the field trip attendance.

Reaction Papers

Students write one-half to one page weekly “reaction papers” to reflect upon their classroom experience or topics discussed in class. Students react to topics that strike a chord with them, often using this as a venting mechanism, and tie the discussion to personal experiences. I tell the students “Some of the issues we discuss in class may be controversial in nature. Write your reaction about a topic or group of topics we discussed in class. Here is an opportunity for you to express your feelings on paper. Some of you may not want to contribute to class discussions, but you have an opinion. This is your opportunity to vent.”

Students submit the reaction papers for credit on a weekly basis (either in hand-written or email format) or at the end of the quarter in a bound diary. This provides the student with an outlet for self-reflection, expression of viewpoints, and individual student-teacher dialogue.

Inventory and Data Collection

Pilot Study. Since approximately August 2005, I have been observing students in my environmental science classes. As extra credit, I offered students the opportunity to provide weekly “reaction papers” of their classroom experiences. Some students took advantage of the prospect, which provided me
with insight. In addition, toward the end of each quarter, students' completed the environmental science inventory to provide a “snap shot” of demographics and their classroom experiences. The inventory was “tweaked” each quarter. The pilot study assisted in uncovering themes which were necessary for performing the literature review and designing the future study.

*Data Collection.* The data was gathered from students' writings. Students’ perceptions of the course were analyzed and interpreted from various sources, as follows:

- Weekly reaction papers
- “Cold writing” exercises
- Environmental Science Inventory
- Observations of students during class sessions, class breaks (before, midway, and after class), and after-school telephone conversations in the form of field notes

Every week, students wrote their reactions to topics discussed during the lecture. Students typically wrote one-half to one page of material. The reaction papers were maintained in my home office during the duration of the study. If the peer reviewer (e.g., student colleague) or any outside committee member reviewed the raw data, a label with a pseudonym was placed on students’ names.

Not only did students provide reaction papers but I maintained notes of my observations of students' reactions, including class dialogue, comments, and
questions. Since I have a hearing disability, a tape recorder assisted in capturing
dialogue during the study (e.g., used as back-up support). Consequently, email
correspondence and phone conversations held during off hours were noted if
relevant to the study.

Approximately nine and ten weeks into the course, the students performed
two spontaneous “cold writing” sessions to examine explicit memory. When the
students arrived to class, they were asked to produce a clean sheet of paper and
list either a) every topic discussed in class or b) whom they shared information
with concerning the course and which topics were shared. The session was
timed for approximately five minutes. At the end of the session, the students
were asked to review their lists and look for shared qualities between the topics.
They assisted in establishing a list of categories (per their review) and a
discussion ensued. A concept map was created on the board for all to view.

An Environmental Science Class Inventory is a survey-like “snapshot”
describing demographics, attitudes and beliefs of the non-science majors
enrolled in the study. The students were asked to recall their opinion of specific
elements in the beginning and at the end of the course, preferred method of
course delivery, voting intentions, and comfort level concerning past class
discussions. The inventory was administered to the class during the eleventh
week of the quarter. A copy of the inventory is provided in Appendix C.

Data Analysis

Like musical compositions conveying thematic undertones within the
movements, descriptive data carries an underlying structure awaiting classification. In thematic analysis, specific patterns are identified and placed with corresponding patterns (Aronson, 1994). Themes in qualitative research may be described as patterns found in information that describe and organize possible observations or possibly interpret aspects of the phenomenon (Boyatzis, 1998). Themes may be outwardly observed or latent. Boyatzis (1998) states themes may be initially generated inductively from the raw information or generated deductively from theory and prior research.

Following the phenomenological aspects described by Creswell (2000) and Pollio (Pollio, Henley, & Thompson, 1997), I read the reaction papers and extracted significant statements focusing not only on meaning units but a sense of whole (hermeneutic analysis). This procedure was performed repeatedly on the reaction papers until saturation occurred. These coding statements were grouped to form initial themes and later developed through selected quotations and narrative format (Spiggle, 1994). Similarly, the lists produced during the cold writing exercises were discriminated, extracted and categorized to create a theme, as presented through selected examples. Categories from the reaction papers were revisited and data were analyzed for possible new categories and relationships (Merriam, 1998). Refining of categories continued until saturation occurred.

The reaction papers and cold writing exercises were triangulated with the observational field notes and environmental science inventory. This convergence
among multiple and different sources assisted in dependability and confirmation of
the data (Creswell, 2000). The systematic sorting through data to find
common themes and categories not only supported data, but brought
contradictions to light. Contradictions and anomalies are important indicators of
the complexities associated with phenomena. Richardson (2000) refers to this
as “crystallization” since there are more than ‘three sides’ from which to approach
the world.

Graphical representations (e.g., bar graphs, pie charts) were created to
provide a pictorial “snapshot” of the results. Patterns and themes revealed in
students’ responses were used to create a concept map to assist in developing
theory.

Ensuring Credibility and Confirmability

To ensure the credibility, a fellow science education doctoral colleague
performed a peer examination of my logic path toward interpreting reaction
papers, cold writing exercises, Environmental Science Inventory, and
observational field notes. The doctoral colleague signed a form attesting to her
capacities in the study (Janesick, 2004). In addition, my major professor and
committee members were consulted concerning the findings. A copy of the
doctoral colleague’s attestation is provided in Appendix D.

A descriptive research study, like good blues, needs a passionate cry for
honesty, lyrical realism charged with taut sensibility, and underlying optimism of
hope (Oliver, 1994). As in music, the art of dance can be used to demonstrate
the need for honesty involved in qualitative research, as follows:

Qualitative researchers have an obligation to fully describe theoretical postures at all stages of the research process, just as the choreographer fully describes and explains each component of a dance plan. As a choreographer, I was always looking for the asymmetrical movement in order to tell the story in some kind of symmetry. (Janesick, 2004, p. 8)

Honesty is important in a descriptive research study because, in my case, I am using “the self as an instrument” (Eisner, 1990). Eisner (1990) notes:

researchers must give some frame of reference and some set of intentions….this is done most often without the aid of observation schedule; it is not a matter of checking behaviors, but rather of perceiving their presence and interpreting their significance. (p. 34)

Since I was the research instrument in my dissertation study, I am providing my viewpoint as the “researcher’s lens.” Creswell (2000) states when a researcher refers to ‘lens’, it mean the inquirer uses a viewpoint for establishing validity in a study. By creating a lens showing the role of a researcher, a narrative account is established to incorporate this reflexivity.

*The Role and Lens of the Researcher*

In the research study, I was both the instructor of the undergraduate environmental science course and the researcher. As a researcher, I was the instrument for data collection, analysis, and synthesis. As instructor, I was the one who purposefully embedded controversial issues into the course, thus, my perspective influenced class lectures, the interactions with students participants, and research observations. My unique background is important to establish the context for the reader. I was both an environmental professional and an
educator. My “real-life” experiences as a scientist working with governmental bureaucracies and oil corporations was a source for the personal vignettes I delivered in class lectures, offering an authenticity to my work.

Exceptional to the field of science education and science education research, I have over 20 years of professional experience in the field of environmental science. I entered college in 1979 at the age of 16 and in 1983 earned a Bachelor of Science degree in Environmental Science at the age of 20. I was usually the “token” female student in class at Florida Institute of Technology and later became the “token” female working in a man’s field. I am intimately familiar with the inequalities, such as the lack of professional respect and pay discrimination, working in a male-dominated science world. I worked in multiple settings from employment as a chemist in a laboratory, to field supervision with mobile drill rigs, to senior level project management in environmental engineering firms. After specializing in petroleum and hazardous waste cleanup and working in the environmental field for several years, I pursued a Master’s degree in Toxicology at University of South Florida. The decision to pursue the degree was influenced by the death of my father, who had succumbed to an occupational illness related to his work in the plastics industry. I later became Vice-president of a financial firm that loaned money to environmental firms for petroleum cleanup.

One may wonder, “Why is a trained environmental scientist working toward a doctoral degree in science education?” My desire to teach and work in
the field of education goes back to 1984 when I taught “English as a Second Language” in Caracas, Venezuela. Students’ ages ranged between eight and 13 years old, providing my first experience dealing with children. After I returned to the United States, entered the work force, and later left for graduate school at Florida Institute of Technology, I remembered the pleasure I found in teaching. I changed my graduate degree from Environmental Science to Science Education, transferring to Florida International University to earn a Master’s of Science in Science Education—Chemistry Specialty. This was the first step in my formal teaching/learning of science. While putting myself through graduate school, I taught chemistry laboratory classes at a community college and gave private English lessons to Spanish-speaking women. My pursuit of the teaching field came to a halt after interning in Killian High School in Miami, where teaching left a “bad taste.” I vowed that I would never teach children in the United States because of their disrespect and behavioral problems. If I were to teach again, it would have to be in an adult setting. Since April 2005, I have been teaching environmental science as an adjunct at a local college for five quarters.

In 2002, while still working full-time as an executive for a financial company, I finally embarked upon my doctoral degree in Science Education. This enabled me to further my understanding of the research underlying science education. The idea of science education as a research endeavor appealed to the “scientist” in me. Also, the interactions of science, technology, and society (STS) presented a context for my growing interest in morality, ethics, and
altruism. After entering my forties, I experienced an awakening to the world of charitable endeavors, an awareness of the use and abuse of politics in society, and the need for a voice for those without one. Even though I have always been politically middle-of-the-road to liberal, I found myself drawn into political activism as a necessary pursuit to “change the world” and “fight for the oppressed.” I do not have children and felt that it was my societal duty to educate the public, enlighten college students about the wonders of science, and bring awareness of the plight of social injustices. Out of a practical and financial necessity I am self-employed as an environmental scientist. My life pleasures are derived from my avocations, including college teaching, filming oral histories of women and the elderly, and producing and hosting a public access television show. The public access television show addresses a feminist perspective on current events and politics, but also promotes causes and non-profit charities. This perceptual screen, as derived through my professional work, formal education about teaching science, and my avocations, influenced my research.

Institutional Review Board

I have completed the Human Participants Protection Education for Research Teams online course by the National Institutes of Health. In accordance with the Institutional Review Board (IRB), I submitted my application, Adult Informed Consent form, and Environmental Science Inventory. In addition, I submitted a letter of support from the college where the study was performed. I received Expedited Approval for IRB #104800 on July 11, 2006. A copy of the
Adult Informed Consent form is presented in Appendix E.

Students enrolled in the environmental science course were considered the “participants” in the study. The participants (adult students enrolled in an environmental science course) who prepared reaction papers, performed the cold writing exercises, and submitted the Environmental Science Inventory were given a consent form. The consent form described the study, including the risks and benefits of participation. Participants who signed the form approved the use of their descriptive data in the study. Participants did have the option to refuse to sign the form without penalty.

The descriptive data, as well as the consent forms, are available upon request to IRB reviewers of the study. Confidentiality of the participants was maintained to the best of my ability.

*Ethical Considerations*

During the study period, I collected reaction papers from students yielding personal information and thoughts. Conservations held during classroom time and off hours (e.g., telephone conversations) were observed and noted. Information exchanged between students and I was kept confidential throughout the study. Pseudonyms were used in the narratives and dialogue descriptions.

I was sensitive to ethical considerations regarding students’ revelations of information deemed harmful or unlawful in nature (e.g., drug activity, physical abuse, suicidal thoughts). Fortunately, this type of situation did not arise. If it had, I would have consulted with my major advisor, school authorities, and
possibly law enforcement officials if deemed necessary (i.e., endangerment).

Summary

To ensure the credibility of the dissertation study, I researched qualitative methods and consulted with experts in the field. I described the research study involving the environmental science course I teach in detail and I have disclosed my background and beliefs with candidness and honesty. To assist with crystallization, I derived data from students’ responses (e.g., reaction papers, cold writing exercises, and environmental science inventory), observational field notes, and had a science education student colleague provide a peer review.
Chapter Four—Presentation of the Data

Introduction

Data from each student was analyzed in an attempt to reveal his or her responses to the use of controversial issues in the classroom. The data were analyzed to manifest students’ lived experience in the environmental science classroom. The richness of the data gathered through students’ reaction papers, cold writing exercises, and field observations crystallized with the results of the environmental science inventory.

The research question posed was, “How do the students respond to controversial issues embedded in the curriculum of an undergraduate environmental science course consistent with the science education reform movement?” Subquestions (SQ) emerged as data were collected and analyzed:

- Which features of controversial issues triggered responses? [SQ1]
- Were there signs of attitudinal changes and positive environmental actions? [SQ2]
- Were there any signs of skepticism and reflective thinking? [SQ3]
- Did generations react differently? [SQ4]

The research question and subquestions are addressed in each section of Chapter Four. Students’ responses to controversial issues in the classroom are discussed as follows: expression of cognitive dissonance, reactions to justice
issues, signs of skepticism and reflective thinking, and conservatism in the classroom. Students’ attitude and behavioral changes during the course are addressed. Students’ sharing class discussions with family and friends emerged as a popular theme and are further examined. Students’ reactions to me, as a person and instructor, are discussed. Students’ response to the implemented instructional methods, including class discussions and group activities are reviewed. The generational responses of the course are examined. Although not a formal research question, a repetitious theme emerged worthy of discussion: provocation of student interest in environmental science. Students’ interest in environmental issues related to their personal lives and responses to new information are reviewed.

Demographic Overview of Students

The environmental science inventory offered a “snapshot” of the students who participated in the inventory during the Summer Quarter 2006. During the 12-week period, 66 students were enrolled for which 79 percent were females and 21 percent were males. The generation makeup was 35 percent Millennials, 51 percent Generation X’ers, and 14 percent Baby Boomers. The years since the students studied science are presented as follows: zero to five years (35 percent), six to 10 years (24 percent), 11 to 20 years (30 percent) and greater than 20 years (11 percent). Participants were enrolled in various areas of study, including paralegal (35 percent), criminal justice (32 percent), business/marketing (12 percent), and accounting (11 percent). Frequency data depicted in tables
and charts are presented in Appendix F.

*Responses to Controversial Issues in the Classroom*

This section describes the results of Subquestions [SQ1 and SQ3]. The influence of cognitive dissonance and the elements of a controversial issue (i.e. justice) are discussed. Emerging signs of students' skepticism and reflective thinking are reviewed. The conservative students who resisted reflective thinking are evaluated.

According to the results of the research, students responded to controversial issues that were central to justice. In other words, students showed reflections of cognitive dissonance or disturbances when exposed to cases of injustice or unfairness to vulnerable parties. The dissonance agitates their ingrained value systems. Most students self-reported feelings of disturbance and responded to the revelations of bioethical controversies and science atrocities showing dissonance, emotion, and shock. However, some students appeared cold or unresponsive to classroom discussions. These students occasionally winced during politically-charged discussions and requested that the “class stick to science and not politics.” Their dissonance, if any, appeared toward the presence of “Bush-bashing” and not the science atrocities and bioethical issues discussed in class.

*Cognitive Dissonance Responses.* The use of controversial issues in the classroom prompted cognitive dissonance within the students. These responses ranged from mild disbelief to shock (both reported by 41 percent of the students),
an expression of cognitive dissonance. The topics of discussion, which consist of sensory input, triggered various emotions including empathy and anger. As empirically shown in animal and human studies, Information from sensory systems trace two pathways: the amygdala (emotional arousal) and cognitive pathway (hippocampus) (Fried et al., 2001). Models showing the “Use of Controversial Issues in the Classroom Model” are presented in Figures 2a and 2b. Not only did students show signs of cognitive dissonance, but light was shed on the elements necessary for an issue to be “controversial” according to students. Throughout the course, controversial issues were introduced in an open discussion forum held the first 45 minutes of instructor lecture. According to the Environmental Science Inventory, 61 percent of the students were aware that environmental science contains controversy and 42 percent of the students were aware of the connection between politics and environmental science. Newspaper articles or real-life scenarios with moral or ethical implications were presented to students as part of the lecture throughout the environmental science course. Analysis of the reaction papers showed certain topics surfacing and resurfacing, as students described their “disturbance” to the issues presented. Students commonly discussed the following scenarios:
Figure 2a. Use of controversial issues in classroom model showing elements of a controversial issue
Figure 2b. Use of controversial issues in classroom model showing emotional pathways
The Stuckey’s scenario—A benzene contaminated potable well is located at a former Stuckey’s restaurant/gas station. The rear of the restaurant had been converted to low-income apartment housing. Until I formerly complained, the potable well had not been sampled for the last three years. The state-designated environmental agency will not treat the potable well, which is used for patrons of the restaurant and the apartment tenants, because the benzene levels (0.25 micrograms per liter) do not exceed the state drinking water standards (1 micrograms per liter). Benzene is a Class A carcinogen and the government is refusing to treat the contaminated water as a precautionary measure.

The CHEERS pesticide study—The study entitled Children’s Environmental Exposure Research Study (CHEERS) offered 60 families located in a low SES area of Jacksonville, Florida $970, a free camcorder, T-shirt, and framed certificate of appreciation for using their children in a pesticide study. The study sponsored by the EPA and the American Chemistry Council, studied how chemicals can be ingested, inhaled or absorbed by children ranging from babies to 3 years old.

Hiroshima and Nagasaki—The events of August 6 and August 9, 1945 were recapped, focusing on ethical aspects. The effects of radiation in humans and the environment were examined.

Depleted uranium and white phosphorus—The use of weapons of mass destruction and the resulting health effects were examined.
• The Brooksville Public Works contaminated site—For approximately 45 years, arsenic, benzene, and polyaromatic hydrocarbons have contaminated the soil and groundwater at the county owned and operated site facility. The facility borders the backyards of an African-American neighborhood, whose residents have suffered health effects (i.e., miscarriages) possibly related to environmental effects.

Students’ reaction papers described their dismay in the government, the shock that children were used as “guinea pigs” in studies, and the connection between greed and profit concerning the abuse of society’s underprivileged. Their value systems were agitated and feelings of dissonance were expressed.

A young female student named Mandy believed the poor were taken advantage of and understood the potential health risks behind the CHEERS study. She is a serious student, very quiet in class, and enjoyed expressing her thoughts in the reaction papers. She expressed her concerns as follows:

I found the article in “St Pete Times” to be very disturbing. I can’t believe that the EPA and government would actually do anything that would put children’s health at risk. I think there are two reasons why they went to the poor. The first reason is because they think they are so desperate for money and will do anything, even harming their own children. The second reason is they are less educated and they don’t know about pesticides and how harmful it could be to children because their immune system is not as strong as an adult. I don’t have any children but if I did, I would never put their lives in harms way now matter how poor I was!

One student named Shaneka described her distress concerning the CHEERS study and wrote her reaction about the topic on several occasions. Her words were very emotional. Shaneka is a mother, an animal lover, and
evangelical. For her term paper assignment, she described the plight of the
western wild mustangs, which are being slaughtered for their meat.

We talked in class last week about how a mother would allow
her children to be the guinea pigs for science. I think it is a
downright disgrace. I would never in a million years put my child
through such a thing. To think some of the class was for it! There’s
not enough money in the world that would make me put my child
through so much agony. Love is deeper than that for me, especially
when it comes to my children.

I just want to say that killing innocent creatures is a vicious and horrible
thing to do. I think that for someone who would do such a thing should
be punished the same way as a person who kills another person. For
someone to do something that he has to be a coward! Sick in the head!
Just downright evil! If God created the earth, didn’t he also create the
people as well as the animals? Whatever happened to “Thou shall not
kill?”

During the course, Shaneka described feelings of dissonance when she
wrote about her irritation with a fellow student in class. Robin, a boisterous thirty-
something female student, interjected her opinions on a weekly basis. She
stated, “Sometimes sacrifice is necessary for the good of all” and “As inhumane
as it appears, we learn from these experiments.” Robin will be discussed further
in Chapter Four’s Conservatism in the Classroom. Similarities between her
comments and those of ex-military students were observed during the class
discussions. Shaneka noticed and acknowledged the coldness in Robin’s
contributions to the discussions. She wrote in a reaction paper:

There’s one person in our class that just really irritates the hell
out of me! She sits in the back. She comes off as if she has no
emotions or concern about anybody’s life, even children.

Like many of the students, Teresa, a single mother with two children,
directed her reactions concerning the pesticide study toward frustrations with the
government. Her sentiments are expressed as follows:

My biggest reaction to class was the study being done in
Jacksonville involving the effects of pesticides on children.
I bet this was the thing that got everyone. I bet that was your
intention. It is very disturbing that the government, who is
supposed to protect us, is involved in putting our children at such
risk so intentionally and in a way that takes advantage of low income
people. They are offering more than a hell of a lot of money, which
can make a real difference in their lives. The difference between
tightening your belt, or having a good meal to give to your children,
paying your rent or being evicted. It’s so disappointing that with all
the wonderful capabilities of this country we stoop so low.

A similar opinion arose from a male student in his mid-thirties named
John. John is following in his mother’s footsteps by studying to be a medical
records assistant, after trying a stint in chef school. He was very articulate in
class and a straight “A” student. He wrote:

I found our first class discussion to be quite interesting and
thought provoking. I am deeply saddened and disturbed to continue to
hear incessantly of many company’s disregard for the environment
and the many loopholes they find by lobbying on Capitol Hill to
sympathetic politicians.

Harry, a Baby Boomer student, is in his mid-fifties, served in the U.S.
Navy, and is seeking a college education for employment purposes. He has
been working part-time in retail to make ends meet, even though he is a trained
mechanic. He was very vocal during class discussions and harbored deep
distrust of the government. He wrote a paper on solid waste disposal and
recycling in harsh environments based on his living experiences in Antarctica.
His disdain for the government and flare for wit are expressed as follows:
If ethics or the lack of ethical values are involved in the testing, there are two groups of animals that should be involved before using true lab rats. These two species occupy both the legislative and executive branches of our government. The President and both houses of congress make perfect lab rats. Being devoid of any ethics, or generally any human emotion, as they look after their own welfare and being, I can’t think of a better choice.

Harry shared his personal insight about the use of human experimentation and the lack of informed consent this way:

Even though prisoners were mentioned in testing chemicals, you should not forget that the largest group of human lab animals were the United States military. During the early and mid-fifties, my father, on at least two occasions, was told to stand in a trench and duck when told so. A few minutes later, a nuclear bomb was detonated just a few miles away. At his house in California, he still has a few pictures of the blast and the mushroom clouds.

The central assumption of cognitive dissonance is human beings cannot tolerate inconsistency, trying to eliminate or reduce it (Zimbardo & Ebbesen, 1969). If something “does not sit well” with a person and dissonance occurs, a motivation within the person pushes its reduction through self-rationalization or overt demonstration against the dissonance (i.e., actions). One bright student Kelly wrote justification of the human experimentation on orphans in the 1950s, by explaining the children were “owned” by the state. Kelly uses the word “Sassy” in her email address, which clearly describes her vibrant personality. In her own mind, her explanation may be the only way she can accept the facts:

The testing of orphan children in the 50’s and 60’s...back when children were awarded to the states and became orphans, I believe that the State felt that these children belonged to them. So they felt they had no one to answer to by having testing done on these children. Since these children belonged to the state, they would not have to get permission or make sure the children understood what was being done
and why. Over the years I have read stories and articles on horrible things done to orphans, like chemicals, radiation, and electrons to the brain. No one knew about these and no one tried to stop it. Who did you go to? The states felt they owned these children and they could do as they pleased.

Actually many students echoed the sentiment that money is the root or motive behind human testing. Lisa, a bright student in her mid-twenties, expressed a common sentiment among students, spelling it out in simple terms, “To me it is a shame that money holds so much power in this world! It makes me sick the way the government works to give people money and stuff to put their kids in danger.” Lisa wrote strong reactions on her disgust with the government and how paranoid she was after hearing about food safety issues.

One forty-something student named Liz, often spoke of sharing class discussions with her college-age daughter after each class. She is divorced and trying to earn an accounting degree to gain financial independence. She described her feelings about the government in detail:

I feel angered that our government does not want us to hear about what’s going in other countries so they don’t have to admit what’s going on in our own. The testing they do on our own citizens is just as bad as some of the things that are done in other countries that they want to punish. It’s like they feel our own are disposable. A disposable society. As long as they are alive to reap the monetary benefits today, who cares about what happens to future generations? It’s a government run by greed.

Terri is a well-dressed, career girl who worked for several years before deciding to attend college. Her parents are prosperous farmers and she was raised with evangelical values. Her reaction papers often described her growing uneasiness with the course discussions and a questioning of societal ethics.
Terri’s emotions about the Brooksville contamination site were apparent:

After reading the article on “Toxic Indifference” I find it absolutely amazing how governments, counties, and states can turn their heads and pass things like this off. It just seems like no one wanted to take responsibility and they hid behind “Oh, I thought they were taking care of it.” People see right through people that play the dumb card. These county representatives have lied, hid, ignored, covered-up (you get my point) the REAL dangers and have harmed a lot of innocent people. And for what? To save money? To be lazy? To hid their ignorance after so many years? It’s like when you tell a lie, the longer it goes on, the more severe the punishment and humiliation is going to be once the truth is revealed. I believe they saw this and started finding ways to protect themselves from exposure and humiliation. Now finally later all these years, they don’t only look bad…they are murderers. Killers of people’s rights to be informed and protected. Killers of their right to freedom and live in a country where they are told the truth.

Residents have been lied to, played with, put in harms way, shoved to the side and have been “invisible” to these state and country representatives. I can only imagine what these people have been through and the evil they know is out there. I have a hard time stomaching the reality to tell you the truth—and I only know what I read. I’m sure if they told me their entire life-long experiences first hand, I’d break down and cry. Hell, I probably wouldn’t sleep for weeks. It’s so sad that in this world people aren’t treated as equals. In God’s eyes, we are all equals. He loves us all the same, no matter what the sin. I believe God rewards and punishes us for our actions. I have to remind myself before I get all pissed off about this, that God doesn’t let people like that sleep well at night.

*Students’ Responses to Issues of Justice.* Students’ responses to controversial issues discussed in the environmental course showed degrees of cognitive dissonance related to injustice. Reflections of dissonance were described through classroom observations, reaction papers, and cold writing exercises. For an issue to be deemed controversial, elements of injustice and/or inequality were essential. The students were disturbed by the intentional
experimentation with vulnerable populations (e.g., children, animals, poor/homeless) for the purpose of greed. Students were affected by the neglect or the intentional inaction of the government to treat contaminated groundwater. Students recognized the cases discussed in class were real and located in their hometown. A student wrote, “I am now worried about the purity of water we are drinking. I wonder if the potable water our community uses is good enough to drink without getting sick?”

Students proposed punishment as a solution for described injustices, stemming from cognitive dissonance and the need for equilibrium. Many recommended that victims of injustice seek lawsuits and monetary compensation. John, the medical assistant student, frequently recommended strong punitive measures as retribution. Most of his opinions were strong and definitive:

The doctor hired by Johnson & Johnson after retracting articles written falsely is disgusting! He should have been sued and tried as a criminal. Johnson & Johnson should be held accountable legally for hiring a criminal and their products should be boycotted.

The homeless people in St. Pete hired to remove asbestos from a condemned building should all take on the city for damages. The woman should be sued and the direct individuals involved should face criminal charges.

Susan, a mother of two young children, is a female student in her late-twenties. She moonlights at a local hotel when she is not in school. Her reaction paper revealed a similar sentiment:

Quaker Oats and MIT should face heavy monetary damages to the orphans experimented on with radiation that are still living. Big
companies and higher learning institutions should be held accountable for damages during a time when there were no laws to protect these people from exploitation. I say this because it is a principal involved and any amount of money is secondary to the deliberate loss of human life.

The students were very sympathetic because the victims of injustice were vulnerable populations: children, animals and the poor. Many felt these populations were uninformed and deliberately targeted for capital gain. They accused politicians and the government as the driving force behind the environmental controversies.

Lisa is in her mid-twenties attends college during the day and bartends in the evening. She appeared to be well-read on current events and frequently contributed to class discussions. She has a soft-spot for pets and all living creatures, boasting she owns three dogs, two cats, hamsters, and fish. She wrote:

About Stuckey’s…Honestly, I believe that is inhumane what they are doing to innocent people. The tenants are low income families. They should have the right to know.

During the discussions of using vulnerable populations for bioethical studies, there were a couple of students who suggested using prisoners. I explained prisoners were considered a vulnerable population by definition and in the past and they were used to study the effects of carcinogens, such as radiation. Mary, a criminology student in her mid-thirties, offered this opinion:

The question was asked, “How do you feel about the government allowing certain corporations to use prisoners to be experimented on in testing chemicals?” I feel that there is no problem as long as there are ethics involved. The prisoners have a right to
know exactly what they are getting into including before, during, and after.

Jawanda, a female student in her mid-forties, is raising her daughter’s grandchild. She is studying to be a medical assistant and often shares class discussions with her husband. She explained her philosophy concerning the root of the problem. The theme of government institutions and politics surfaced:

Greedy businessmen and politicians of both parties have impeded cleaning the environment in the name of the almighty dollar. We must rise up as our fore-fathers and before us to ring in justice for all across this great land.

John, the medical assistant student, explained his philosophy that “ecotourism” caters to upper socioeconomic groups, defeating the purpose of environmental education. He noted the class discrimination:

Theoretically, ecotourism is great, but when it caters to only the upper echelon of society, and the members of the upper echelon are trampling down on plants, it defeats the purpose of trying to education people about environmentally-sound living. In addition, this form of tourism should be affordable and attainable by everyone.

Myra, a female student in her early-forties, brought her nature-loving spirit to class during the discussions. She appeared to be a true “earth mother” and wrote her term paper on the decline of Druidism in Celtic society. She often spoke up in class with anger and determinism, apologizing after for “voicing her opinion.” Myra had this to say about the first chapter of the textbook which tells the saga of Easter Island:

The classroom discussion and Chapter One seem to have the same theme: ignorance and arrogance. Until people truly care about and know about what is going on around them, we
are doomed to repeat history. When politicians finally get off their soap boxes and immerse themselves into the working part of society and when the working part of society stops making excuses for themselves, then will there be a time we will be about to work toward a sustainable society.

Another ongoing controversial topic in the course was one citizen’s right to put in a plastic lawn in his front yard. The cost was approximately $15,000 and the man received notoriety after he was confronted by the authorities. The use of “non-herbaceous” material, such as a plastic lawn with a mesh base, is against the City Code for lawn coverings. Even though no emotional or bioethical issues were tied to this issue, it hit a chord with the majority of students. Many felt this was a case of injustice based on absence of freedom, inasmuch the lawn was actually an environmentally-friendly alternative to traditional sod. Mandy, a Millennial, and John, a Generation X’er, commented on the absence of personal freedom regarding the owner of the plastic lawn:

I don’t think it should be any of the city’s business whether or not he has fake or real grass if he is paying for it…just as long it isn’t an eyesore.

I think that this man should get to do whatever he wants with his property. The government is getting way controlling on telling people what is and is not allowed on their own land and their own property.

Terri described a contrary opinion. She lives in a deed-restricted neighborhood and relishes the idea of having limits on property use. She stated the following:

Regarding the guy with the plastic lawn, I live in a deed-restricted area and the neighborhood is absolutely beautiful. No one’s car is upon blocks in their driveways, their yards are alive and beautiful and there are no child’s toys on the front lawn. I appreciate deed
restrictions because it adds value to your house. If this guys gets away with the plastic lawn, this will cause a chain reaction and the neighborhood will probably go to pot. If I lived in his neighborhood, I wouldn’t complain about his yard, but if it came a neighborhood issue and we had to vote, I would vote with the opposing side.

Students’ Emerging Skepticism and Reflective Thinking. The students began writing about how they were beginning to reflect upon the lectures and the class discussions as the course progressed. They began to question their long held beliefs and thinking patterns as skepticism surfaced. They desired to assess available information and seek its source, prior to forming an opinion. Students showed in their writings they were not accepting printed information at face value. They began to fit the information presented in class with their prior schema to develop newly formed opinions. A few students asked philosophical questions and pondered the future of the environment with the political status quo of the United States.

Terri is a middle class female student in her mid-thirties studying in college after years in the workforce. She is proud of her Christian heritage, Republican background, and charitable work. She has “tree-hugging” friends and admittedly knew little of environmental science:

This is going to be a complete learning experience for me, because I’m not current on many of the environmental issues today. I know that the Earth is hotter causing the hurricanes to be stronger and more dangerous. I know very little about the popular issues that we face year after year here in Florida and globally, I’m ignorant.

During the course, Terri wrote very detailed reaction papers and emailed them to me immediately after class. She described how she could not wait to go
home to tell her boyfriend all she learned in class that evening. As the term progressed, she expressed great interest and a refreshing curiosity regarding the topics discussed in class. She followed up on the class discussions by verifying information on her own.

Kelly is in her late twenties and is outspoken about her views on drilling in Alaska. She wrote a term paper on the oil companies’ neglect of pipeline maintenance and the unpublicized spills that occur regularly in Alaska. Kelly, like many of students enrolled in the course, juggles work, child-raising, and college attendance. After I discussed the effects of depleted uranium during the Gulf War and current conflicts, she wrote these comments in her reaction paper:

The whole situation makes me leery of anything that the government has to say and makes it harder to choose who to vote for in the elections. It is amazing that one country can have so many professional liars and we actually pay them to do so. Just to give you a little insight, my brother was in Iraq twice and is now complaining of pain in his back, legs, and headaches. Of course, the doctors have no idea what is going on. He just takes his 800 mg ibuprofen and his flexural and goes on probably happier in his ignorance to the fact that he is dealing with the government’s blindfolded opinion that nothing over there could have done this to him. The insight you gave today was very valuable and hit home. Thank you so much.

The discussions of both Agent Orange and depleted uranium appeared to connect students on a personal level. Students either knew friends or had relatives who were affected by undiagnosed ailments caused by possible chemical exposures during their military deployments. These discussions were sensitive and possibly difficult for students to hear due to the current conflicts in the Middle East. At the time of the study, the United States occupied
Afghanistan and Iraq and Israel was involved in a conflict with Lebanon. Terri, who is a registered Republican and voted for George Bush, who wrote a very passionate reflection:

I’m so sad for the soldiers that are suffering from DU. I’m also sad for their families because they see their loved ones in such pain and can’t do anything to help them. This is the world’s largest tragedy in my eyes (you’re probably thinking that I don’t know the half of it, right). These men deserve to play with their children outside and live active, health lives. I wish all of the truths about our troop’s exposure to harmful chemicals would be front page news and top stories for national news stations. This country is killing the very people who are sacrificing their lives to protect it.

Our troops love this country but this country does not love them! My sister is my best friend and I watch her get so pissed off at the VA Hospital doctors when her husband, who is as veteran of the Gulf War, is ignored, mistreated, and shoved aside when he goes for treatment for his pain. To this day, he has not gotten an explanation or diagnosis for all the pain he’s in. He is 34 and he walks like he’s 80. I am very sensitive to this. I was just talking about this today—I believe that if you fight in a war, you shouldn’t have to ever pay taxes again—ever! I think it’s the least this country should do!

Continuing with the war and environmental exposure theme in the classroom, Terri wrote about the moral implications behind the bombing of Hiroshima and Nagasaki during World War II. The majority of the students, like Terri, had not been taught in high school the full implications of the bombing event and the number of casualties that resulted. Terri wrote:

The statistics of Hiroshima and Nagasaki were devastating! I had no idea so many people lost their lives. It’s sad they do not teach high school students about this. They may teach them about the event, but the number of deaths is left out. I know I would have remembered something as sad as this if it was part of the lesson back then. I remember finding out about Vietnam and I won’t ever forget that. How sad! I do
believe and agree with the majority of the class that the U.S. Military was too quick to drop their new toy. We’re supposed to be a county that is known for our morals and judgment—why would we have dropped this bomb if we were using our morals and judgment? And to drop the second bomb? Now, we’re just showing off. When you told me that we were the only country that has ever nuked anyone, I about fell out of my chair! I didn’t know this. I know nuclear bombs are a huge threat to the world and to find out that we are the only ones who’ve ever used this type of weaponry is amazing.

Terri continued to explore information outside of the classroom and develop reflective thinking skills. After the first class, she emailed questions and comments to me about the lecture. She said that she was taping a special on global warming on the “Discovery Channel” and intended to see “An Inconvenient Truth” at the movie theater. Terri was the only student during the quarter who viewed the film before it left town. She shared the experience with her boyfriend and could not wait to write her paper on the extinction of polar bears.

During one of the class breaks early in the quarter, she told me that she voted for George W. Bush during the 2004 election because, “My parents told me to vote for him and because, well, we are Christian.” I asked her to “keep an open mind during the course.” As we delved deeper into global warming and I distributed a hand-out of the voting records of our state congress and senate representatives, she wrote this:

The review of the House and Senate voting, really, really, really opened my eyes. I think it’s time for me to get involved in my voting and do some in-depth research before I choose another president for this country. I can no longer hold my head up high as a Republican after all that GWB has done. He has put this country
in a bad place, in more sense than just the environment. The more I know about the Bush administration the more I question what’s important to me. I’ve lost respect for him, that’s for sure…all republicans for that matter because their votes show that they’re uninterested in the environment. I’ve learned a valuable lesson here about my voting and values and what I will look for in future candidates.

She continued her discussion about learning and analyzing the lecture material, as follows:

The Environmental Scares we discussed really opened my eyes to the seriousness of the mistakes some people make when taking their findings to the public. It seems that some people didn’t do all the tests or get all the profit they needed to determine their findings. Then of course when the media gets a hold of this information, the whole world goes crazy. But it makes me feel safe to know there are people out there doing research on new medications and pesticides and looking at some of these new developments with skepticism. It’s not my practice to question everything, but it could pay off if I did question some things.

Tamara, an astute female student in her early twenties, makes Dean’s List every quarter. She displayed an interesting view on the health risks of Teflon®, especially birds. Dow Chemical’s website warns consumers not to keep birds in a kitchen due to the possibility of toxic fumes affecting the bird’s health. She reflected on her bird that passed away:

Now that I think about it, I had a bird that was in a cage about 12 feet away from my kitchen. My bird died about 6 months after my Mom had bought a new Teflon® pot and pan set. My bird has been in our family for 12 years but now I’m reconsidering the cause of death. Maybe it was the Teflon. I know that I’ve eaten out of a Teflon® pan, especially eggs and I never thought it could harm me but that will change.

Joey is a young, African-American male student, who literally, by self-admission, grew up “on the streets.” The environmental science class was his
first college course he had ever taken and he bears great pride when saying, “Ms. Tabone, I want to make something of myself. I am so happy that I got into college.” During a class break, he told me “The stuff you are telling us in class is blowing my mind! I never thought about any of these things before!” Joey wrote in his reaction paper:

I also wanted to let you know that I really like being in your class and everything because a lot of this stuff that we are doing in class and talking about, we wouldn’t ever know or think about.

Some students wrote that they are attempting to filter out facts from fiction regarding the news in the media. Their writings are showing signs of increased skepticism and the ability to form self-generated opinions based on cognition. The media, as well as the United States Government, are considered “authoritative figures.” The questioning of motives and bias underlying reporting and governmental actions are steps toward reflective thinking. Tamara wrote her reaction about government and corporations:

The Government and the companies must not be thinking about the effect the chemicals have on the children. We need to be more aware as consumers of what’s going on in society concerning the environment. The media hype is misinforming us on stuff that can or cannot hurt us.

Samantha, a student in her early-twenties changed her major from criminology to environmental science after taking the course. She never missed class and participated in the field trip. She wrote about the need to objectively and critically examine facts:

Other things that surprised me were not so much the environmental issues themselves but the way we are looking
at them objectively. People need to know what is happening in the world today. This is definitely not what I thought this class would be and I am happily surprised. Having knowledge about solid, historical, scientific facts is important so is the will to take action and awareness of our social and political environment. But we need to be able to use all of these things to make a difference and be useful.

Kelly described her skepticism of the media and how people may be duped by sources:

The way things are handled puts me in the mind of “War of the World”, when everyone was in a total panic over an alien attack. Just because one radio network played a mock invasion, no one actually saw the aliens. But people that were smarter and better informed than them said that they were there. So, the aliens were invading. I am not sure that I will believe anything that “they” say in the future concerning what is good or bad for me. I think that I will just use my own judgment. It was gotten me through 28 years so far and I am sure I’ve got a lot more to go.

Students sometimes share common sense approaches and solutions for environmental problems. They seem to offer insight on solving situations that the government has not attempted or approached. For example, when I was lecturing about the use of wind mills as an energy alternative, I explained although the method is very effective (e.g., the Netherlands for the last few hundred years), opponents consider the method an eyesore. I noted there is an abundance of wind in this country, naming examples like middle-America and Chicago, the “Windy City.”

Kelly raised her hand and suggested, “Why don’t they put windmills in Chicago?” I asked about the presence of high-rise buildings.

She deftly replied, “What about putting them on top of the rooftops?”
I exclaimed, “Wow! That’s a great idea! They would be out of the way and can provide electricity for the building it rests on.”

Kim, a divorced mother of two, missed a few classes because her apartment landlord evicted the family. During class breaks, she described her “dysfunctional family” and dealing with her ex-husband. Even though she had hardships, she was always enthusiastic in the discussions, quick to offer an opinion, and wrote detailed reaction papers. She wrote a paper about developers attempting to reduce manatees’ endangered species designation, writing the words “Screw them!” several times in the document. She commented about the government’s lack of response in the Stuckey’s contaminated groundwater case:

I do not like the way the government is using our money not to sue towards making an apartment safer. They need to start running tests to make sure the water is safe to drink and take baths. If the water has 0.25 ug/L of benzene, they should go out and get bottled water for those apartments until they can fix the problem.

Not all of the students in the course displayed emerging patterns of reflecting thinking. Some students held tightly to their preconceived notions and appeared fearful of change. New ideas or departures from comfort zones (i.e., cognitive dissonance) made some students uncomfortable with adopting new thought patterns. Shaneka felt that a plastic lawn defied nature:

Plastic grass is not a good idea to me because God did not create grass for nothing. Everything is created for a reason.

Niki, a student in her mid-twenties, and seven months pregnant with her
second child, finds it difficult to juggle a family, work, and school. She had been
looking forward to taking the course because she had an interest in
environmental science. Unfortunately, she dropped the course in the middle of
the quarter due to a difficult pregnancy. She "believes in the power of crystals"
and disagreed with my discussion of pseudoscience. She wrote this about
politics and the environment:

I really don’t pay too much mind to anything dealing with the
government. I live my life. If I don’t worry about the governmental
stuff, I will be less stressed and happier.

Julie is a devoted mother and animal lover, and is proud of her pound-
adopted Doberman pinschers. She is very soft-spoken and a conscientious
student. During the class discussions, she winced and appeared uncomfortable.

She described discomfort concerning the discussion of politics in class, citing
her husband’s influence:

Monday’s class was very interesting, however, my participation
for the extra credit movie (“An Inconvenient Truth”) will not exist.
I hope another opportunity for extra credit will be available. I live
with a Republican and Al Gore is a hot subject to bring up in my
house. Global warming is a touchy subject. My husband believes
in the notion that global warming is just a hoax drudged up by the
Democratic party. I myself have to do some research on the subject
but it is hard to believe the sources nowadays.

Conservatism in the Classroom. Students with conservative beliefs
showed an alternative response to controversial issues embedded in the
curriculum. A minority of students resisted attitudinal changes and reflective
thinking. Their vision of the material discussed in class reflected a classic “belief
in just world” worldview. Three students in the course articulated mantras typical
of conservative talk radio. Robin, the female student in her mid-thirties, was going through a “messy divorce” and had child custody issues. She appeared to have a chip on her shoulder and showed rudeness during class discussions, often making insulting comments under her breath. When the discussion concerning the Jacksonville pesticide study arose, she displayed a cavalier attitude, saying,

These parents have choices. They didn’t have to use their children in the studies. Oh, well. Sometimes there needs to be sacrifices for the good of all mankind. As inhuman as it appears, we (society) learn from these experiments!

Robin was aware that students and I disagreed with most of her viewpoints. She wrote in her reaction paper, “There doesn’t seem to be a lot of tolerance for opposing views. Defenses go up and emotions are quickly engaged.” Robin was very critical of the victims of Hurricane Katrina, saying, “They should have left New Orleans” and “I blame the Mayor and Governor Blanco for the tragedy.” During the class discussions, Robin often stated, “I wish these people would quit whining. There are a bunch of whiners out there!” Regarding pre-war intelligence and the Iraq invasion, she wrote:

Why is the President always the blame for war? As with all “businesses,” jobs are delegated, so the top is only as good as the information going up!”

Robin, as well as two ex-military male students, often debated issues concerning the invasion of Iraq, soldiers’ exposure to depleted uranium, and post-war health problems. The male students both stated the same sentiment as Robin, concerning war in general: sacrifice of a few is necessary for the good of
all. One male student Robby, a heavily tattooed and pierced ex-military student, stated, “Hey, at least there have been a lot less casualties with this war as opposed to Vietnam. It’s a job. They volunteered for service.” Regarding soldiers’ exposure to depleted uranium and evidence of birth defects of their offspring, Robin wrote:

Although it is unfortunate that there are birth defects related to soldiers over in the war, there are times in life where choices never have a positive effect. Sometimes “a few suffer for the good of many”. Possible solution—freeze sperm before deployment.

John, the medical assistant student, provided his view of the Iraq invasion, offering these remarks:

The War in Iraq is unfortunate but in my view we must protect ourselves from monsters like Saddam Hussein. Despite not having yet found WMDs, Saddam was very dangerous and still is from his prison cell. He must receive a death sentence to send a message to psychopaths in his part of the world.

I read a reaction paper from Ann, who is a mature student in her fifties who served in the military during the late 1970s. She was extremely prejudiced and hostile against “all Middle Easterners.” Ann stated, “I think Bush should have used WMDs, like white phosphorus, on all middle-eastern countries after 9-11 to get even.” The topic of the current conflicts in the Middle East certainly stirred reactions!

Julie, a self-described Democrat, appeared to be influenced by her Republican ex-military husband, who does not believe in global warming. She described the political talk in class as being “too intense for me” and “again, I don’t get into politics too much.” Her husband worked on a naval submarine and
she discounted the discussions of depleted uranium in the class, “My children were born with all of their fingers.” She wished the class discussions adhered to “environmental science” and stated the following:

I am a registered Democrat and I am really disappointed in the Party’s actions within the last few years. I could not stand behind Kerry, a liar, and Edwards, who earned his money from frivolous lawsuits. My husband buys books like “Unfit for Command” and “How to Talk to a Liberal.” He is trying to get me to read these books but I don’t have time. Have you ever read these books? I would like your input.

Julie let her hair down, expressing her honesty in the Environmental Science Inventory. She found the discussions in class to be very uncomfortable, listing “president bashing” as her reason. She stated the environmental course “reinforced my beliefs” and asked “If you are going to show a humorous video bashing one party, why not allow a movie bashing the other political party?” Julie enjoyed writing the reaction papers as an outlet because “it gives you a chance to vent without insulting classmates.” She appeared very timid throughout the whole course and only expressed her inner self because of the reaction papers.

Another student, Dawn, was very red-faced when she approached me during a class break. We had just discussed the Iraq conflict, Gulf War Syndrome, and the rising casualties of Veteran illnesses and fatalities. Her eyes widened and lips pursed as she strained to hold back, “I know you said the lecture today was particularly disturbing but I’m a very opinionated person. I do not agree with everything you are saying this evening. I come from a long line of military veterans back to World War II.”
I explained to Dawn, “Please tell me what you think! It’s OK! I respect your opinion and have great regard for all veterans. Why don’t you at least write how you feel in the reaction paper?”

Dawn explained, “I know you said to be honest but I’m afraid you will hold it against me.”

I said, “Please! I insist! I need you to be honest! Believe me, many in class are very honest. I need to know how you really feel.”

Dawn did not turn in a reaction paper that evening but she was honest in reporting her opinions in the Environmental Science Inventory. Although students do not place their names on the inventories, I matched Dawn’s handwriting to a homework assignment. She wrote that she was very uncomfortable with the discussions and that all aspects affected her. She wrote:

Your opinions need to be toned down. Too much influence on class discussion. Look at all the issue and all sides of the issue. Too far to the left!

Dawn appeared to be in her late-thirties, like Julie, and she shared class discussions with her father. She had planned a three week vacation and I never saw her in class again. She had to take a make-up exam.

*Changing Attitudes about Environmental Science*

This section describes the results of Subquestion [SQ2]. Behavioral changes and activism, students’ sharing with outsiders, and their personal reactions to me are discussed.

The environmental science course is required for all degree-seeking
majors at the college. For this reason, students enrolled in the course may not have had a prior interest in science. The Environmental Science Inventory showed that before the course was taken, 50 percent of the students “somewhat cared” about the environment and 41 percent “cared a lot” about the environment. Before the course was taken, approximately 68 percent watched television programs related to science and the environment. At the end of the course, 47 percent of the students reported maintaining “some interest” and 46 percent reported being “very interested” in the environment.

Students described their past experiences in high school science courses as “boring” and anticipated a similar experience in the college course. Mature students had not taken a science courses in “many years” and expressed “fear of failing” the course. Students had low expectations on the first day of class. Students reported feeling “pleasantly surprised” after hearing the introductory lecture, which included a historical overview of environmental scares. Lisa reported a favorable experience, although she admitted being paranoid about food:

Today was our first day of environmental science class. I have to admit that I thought this would be one of the most boring classes but I actually found it to be quite stimulating. The whole mercury in fish and chemicals in food freaked me out but what got to me the most was the testing on rats.

On the first day of class, Nita was fearful due to the title “Environmental Science.” Fortunately, her fears were quelled after the in-depth historical overview of environmental scares. She commented:
The first day of class is always exciting because I never know what to expect! Even more so with this class…The word "science" has a stigma in it to me. But you made the class very interesting. The sheet you gave us that had a list of topics was neat because a lot of the subjects I simply never knew about. The first one called the Cranberry Scare was interesting and Three Mile Island was good because you drew a picture of the nuclear core.

Veronica reminded me that the class was on Monday mornings, which may not be a popular time to take a science course. Actually, students were quiet and non-responsive at times, requiring much prodding. To Veronica’s delight, the environmental course was not to be dreaded. She commented:

Monday mornings are usually not the greatest for most people, especially if you have to go to school. I was dreading this very thing to be honest. I was hoping that my first day back wasn’t going to be “that boring class.” As it turns out, it wasn’t what I expected at all! It was a great way to start off the week. I never expected to be so interested in science class! I am one that loves to voice my opinion on a lot of things, especially our twisted government. I am glad that I am learning new things about the environment as well as how it affects our health and where we live.

Kelly, a spunky student with her usual “hat full of comments,” wrote this after the first class:

You really piqued my interest with the first class. I thought that going through the history of environmental events was a wonderful icebreaker. It has really opened my eyes to the things behind the scenes that the public never hears about.

As the course progressed through the 12-week quarter, more students expressed their growing interest in environmental science. Some stated the topics of discussions sparked their interests while others voiced their appreciation of class activities as “fun” eye-opening experiences. Students responded as follows:
At first I thought environmental science was “yuck” but it really has become interesting to me. I know that I will leave this class with more respect for the environment than the first time I walked in the door. Thanks! (Veronica)

This class was very interesting. I should be honest by also letting you know that I had not given much thought to environmental issues in a very long time. This is not because I don’t care but because I know as a nation, we’re in a bad situation with how we treat the earth and the reality of it is very frightening. (Carol)

I have enjoyed your class. In the beginning, I had the mentality of “Why do I need to take this class?” and after doing so I am extremely pleased you have taught us everyday things that everyone should know. Anyways, thank you very much for making the class so enjoyable. I think that this class was one of my favorites. (Jawanda)

This has been a complete learning experience for me, because I was not current on many of the environmental issues today. Yes, I knew we have to conserve water and recycle. Have dear “tree-hugging” friends that informed me of the importance of this. I knew that the Earth is hotter causing the hurricanes to be stronger and more dangerous. I knew very little about the popular issues that we face year after year here in Florida and globally. I was ignorant. (Terri)

Behavioral Changes and Activism. Students expressed their growing participation in energy conservation, recycling, and change of home habits, since enrollment in the course. Students conveyed outward attitudinal and behavioral changes (65 percent reported changes and 23 percent reported possible changes). They enthusiastically expressed their desire to influence co-workers, family members, and friends to participate in environmentally-friendly practices. Students joined Sierra Club, recycled copy paper, signed petitions, and influenced co-workers to follow suit. Samantha convinced her boss at Subway to implement recycling activities on the premises. She wrote in the Environmental Science Inventory that she intended to change her major from criminology to
environmental science. Since the degree is not offered at the college she will likely transfer to another college.

Students expressed that they actively shared with others the content of class discussions and lectures. As the course progressed, Terri responded to the course by seeking television shows and movies concerning the environment. She wrote the following:

Oh, tonight on “The Discovery Channel,” they had a piece on Global Warming. I stumbled upon it right at the midpoint of the show. After seeing the end, I scrolled ahead to the new showing of it (12 am to 2 a.m.) and recorded it so I could see the beginning.

I caught the “Inconvenient Truth” last week and the statistics in both movies are all very similar (frightening too).

By the mid-term of the environmental course, Terri began a recycling program at her workplace, an engineering firm. She collects aluminum cans and plastic bottles, bundling bags of the items to take home. The community she where she resides has a curbside collection program.

I bet if I hung out with your for a year, I’d be a completely changed human being. Heck, I’ve been your student for a month and already I’ve started a recycling program at my work with just aluminum cans and plastic bottles and have started to rethink my political views and beliefs all together.

Debbie, a student in late-thirties, is a personal trainer and sun worshiper. She stated her love for Florida weather and the need to preserve the waterways in Florida during a discussion. She expressed these views on recycling:

People just need a little ambition to do the right thing. It is awful to bribe people to do such things but I must admit I always recycled in Michigan and I never do here! Just out of pure laziness. This discussion opened my eyes to the cause and effect of not recycling
so I am going to start doing it now. It is worth it!

Another student, Carol, conveyed the desire to major in environmental science. A Baby Boomer student, she was graduating with her Bachelor’s degree in business at the end of the quarter. Her cold writing exercise listed several terms related to soil and detritus because she said, “My hobby is gardening!” She confessed to me, “Had I known that I could have had a career in environmental science, I would have majored in it. I have always been into nature and this would have been a good fit. Plus, you know me with my mouth! I would love to lobby!”

In an email, Joey wrote he enjoyed the class and was thinking about getting involved in the environmental movement. He volunteers to help the homeless. Sadly, during the quarter, Joey became homeless himself, but still struggled to attend class. He wrote an email explaining his desire for activism:

I also would like to get more involved in more things that are going on at school and out of school and with the community and everything. If there is anything going on in the community and they need volunteers for anything, please le me know and I’d be happy to help out.

Anne articulated the importance of involvement, as follows:

I know I’m going to like this class because I am going to learn so much about my environment that I’ll have to get involved. I’m excited to have an instructor that has such a passion for this subject. I think that if you truly believe in something and you have the opportunity to tell people about it, you can make a difference.

Students felt provoked to clarify information discussed in class and sought further explanations. Several students’ reaction papers reflected the
performance of deeper research into science content and controversial issues
discussed in class. Some students realized the complex relationships between
government, people, and the political will to create changes in the system.

Larry, a male student in his mid-twenties appeared attentive and alert,
although passive in contributing to class discussions. He had friends who were
serving in Iraq and wrote his term paper on the effects of chemical weapons in
warfare. He cited a historical overview of the Geneva Convention, which I used
in a lecture. Larry researched benzene because he was moved by the class
discussion on Stuckey's:

I was surprised to hear that the FDEP hadn't inspected the
water and soil near the apartments at Stuckey's since 2003,
letting it seep into the potable water system. I recently looked
up benzene and the health effects. Benzene exposure has
serious health effects while breathing high levels, which can
result in death. Levels can cause drowsiness, dizziness, rapid
heart rate, headaches, tremors and confusion. Eating or drinking
foods containing high levels of benzene can cause vomiting,
irritation of the stomach, dizziness, sleepiness, convulsions and
rapid heart rate. Some women who breathed high levels showed
irregular menstrual periods and decreased ovary size. It is not
known whether benzene exposure affects the developing fetus
in pregnant women or fertility in men.

Pat is a female student in her early-twenties. She is a self-described
Wiccan who loves nature and intends to move up north with her girlfriend to work
at a wastewater treatment plant. She was a criminology student but later
decided to make a career switch after taking the environmental course. She
wrote:

I was really surprised by all the things going on in Florida that the
government isn’t doing anything about. It really makes me wanna’
get involved and help the environment. I am also excited about the field trip. My dad retired in the water treatment field and so that area has always interested me.

Kelly, who often speaks with force and logic, showed her activist side, saying:

What if these residents all got together and signed a petition and branched out to other neighborhoods with the same issues and end up going to the Supreme Court? There’s got to be something we can do to change this!!

According to the Environmental Science Inventory, 61 percent voted in 2004 and 70 percent intended to vote in the 2006 mid-term elections. It is possible that some of the students may have turned 18 years old since the 2004 election. They showed interest in taking the plunge. Some students may not have voted in 2004 and had no intentions of voting in the 2006 election due to their resident alien status. I know there were several students enrolled in the course from Mexico, Jamaica, Albania, Laos, and Japan. This could have affected data.

*Students’ Sharing Outside of the Classroom.* Reaction papers, cold writing sessions and the environmental science inventory showed that 91 percent of students shared lecture content and discussion topics with family, friends, and co-workers. Carol, a spunky nature-loving, outspoken Baby Boomer, quipped, “I tell anybody and everybody who will listen about this class!”

Sharing the course experience was encouraged by inviting family and friends to the planned field trip. On a Saturday morning, some students shared the “field trip experience” at the wastewater treatment plant with daughters,
husbands, friends, a nephew, a boyfriend, and father. I was very pleased to
meet “significant others” and “extended family members,” and received very good
feedback from them. Veronica, Courtney, and Terri described their sharing
experiences during the course:

I went home and we were watching shark week on the Discovery
Channel. I pointed out to my husband that the murky water is
eutrophic. I felt so scientific! (Veronica)

I liked the sinkhole demonstration and I plan to do that with my kids.
(Courtney)

You'll be happy to know that as I learn all of these fun facts, I pass
the information on to my friends and family. Then, they come back
to me and tell me how they've told everyone they know and we
laugh about their reactions. I love it! You are a good instructor,
Ms. Tabone. I sincerely appreciate everything you do in our
community and in my life personally. I'm happier now that I've
learned the benefits of recycling and doing my part to save energy
to reduce my emissions. I'm rubbing this off on my friends too. It
seems like every one I know talks to me about environmental
issues now that I'm labeled as a tree-hugger. Ha! (Terri)

Personal reactions to me. Students responded in the reaction papers and
cold writing exercises by expressing their opinions to my personal stories of
working in the environmental science field and environmental activism. The
students remembered facts concerning my personal life (e.g., boyfriend running
for congress, my public access TV show) during writing exercises. Terri, who
relishes charitable work, commented on my altruism:

I think it is great as well that you have a television show. It is great
insight to show how one person can make a difference

I commend you for the strength to stand up for what’s right. I truly
look up to you for the good work you do for our environment.
I think your protesting is great! I’m just too busy (maybe lazy) to protest. When your ideas are that strong that you want to tell the world, protesting is the best way—and only way!

On a personal note, I want to thank you for what you do everyday for the environment and the people in it. I enjoy talking to my family and friends about you, your work and how determined you are to “get the bad guy.” With all of the discouraging things you must see and know, you always keep going at it every day. That is so admirable and encouraging. I can only imagine how frustrating your job can be at times, but please know that you are reaching people through education and are making a difference every day. I surely have a whole new respect for science and environmental professionals just after only two weeks! You do a great job!

Responses to Course Instructional Methods

Discussions. Science courses in higher education are primarily delivered through traditional lectures. The environmental science course dedicated the first 45-minutes of lecture to open discussion of news articles I read aloud. During the science content portion, questions and dialogue were encouraged as information was elaborated. Overall, the response to the discussion was favorable, if not preferred, by most of the mature students. The generational differences are discussed further in the paper. Students favored discussion format (24 percent), a combination of Power Point presentations and discussion (26 percent), Power Point presentations alone (17 percent) or writing on the board and discussion (15 percent).

Students relished the “free speech” opportunity in a safe classroom environment. One student wrote, “I am a little shy in class so don’t speak up as much as I should, but this [reaction paper] shows I do have an opinion. Thank you for letting us express ourselves this way.” It became very apparent students
desired the opportunity to be heard as the course progressed. The feedback became remarkably positive as the same sentiment emerged repeatedly, “Thank you for letting me speak my mind.” Maria, a student from Mexico, offered a different insight into the discussion format:

In spite English is not my first language and it limits my ability to understand 100% of the lecture, I can learn the most important points. This lecture is so interesting that I can learn in an easy way. Thank you for your teaching.

Maria gave additional insight and feedback about my teaching methods from the perspective of a foreign student. Her term paper on the introduction of exotic species (i.e., pythons) into the environment was well written and produced a higher quality paper than some of my native speakers. She preferred traditional board writing methods to Power Point presentations, which she felt were “difficult to follow.” Maria wrote about the teaching methods:

The last lecture I liked more than the others. It was easy to follow the book while the teacher is giving the lecture. I like this way more than watching the projector. I like when the teacher draws on the blackboard. It helps keep a picture in my mind about some topics and learn easily. Each class is better and better because my English comprehension is getting better every day.

Introverted students articulated their desire to “be heard” and appreciated the use of reaction papers as an outlet for self-expression. Some expressed interest in hearing how fellow classmates felt and thought about topics, for informative purposes, subtle curiosity, and occasional amusement. Three anonymous students wrote on their Environmental Science Inventories:

I tell my husband about all of our class discussions…more so
because they are just that discussions and you are open and allow us to voice our opinions. It’s refreshing to have a class like this.

Our class discussions have been so interesting. I truly believe the discussions are the reason why so many people in the class have retained so much information.

The most interesting part to me is always the articles and class discussions. This allows me to learn more about my environment and what I can do to make sure it’s around for my children and my children’s children to enjoy.

The discussion format in the class aroused students’ emotions and sometimes provoked heated responses. Respect was demanded and enforced through discussion moderation and the requirement of hand-raising. Robin, the conservative student who prompted arguments, wrote about the reaction of fellow students:

To me it seems that certain students seemed to have some kind of anger built within them and they had a chance to air it out. Debate is good as long as we all can respect each others decisions.

The Monday morning class appeared to be less animated when Robin was absent. There seemed to be less tension in the air and students required prodding into discussion mode. The time, day, and general composition of the morning class possibly may have bearing (e.g., younger students who live at home). The decibel level during the evening class was louder, requiring enforcement of hand-raising and manners. The evening class was mostly composed of working-class students who greatly desired the full college experience and were not in the class simply because “it was required.” Nevertheless, I delivered the lectures with dramatic flare, attempting to not only
instruct but entertain the students. To break up the monotony of the Power Point lectures, I embedded comical animal photos within the prepared slides. Students appreciated “teacher enthusiasm” and it became infectious in class. Two anonymous students and Anne articulated:

My teacher is very interested in her subject so that makes me more interested in learning about the environment.

I like the way we discuss these problems and the teacher’s interest makes me want to keep going.

The other thing I like about class is my teacher is very comical. Some of the topics are boring but they are very educational. (Anne)

Classroom activities. Students responded to the group activities, videos, and demonstrations performed in the environmental science course. Particularly popular was the sinkhole model demonstration, which yielded kudos in the reaction papers and environmental science inventory. Students appreciated going through the weekly homework answers for clarification, the structured organization of the course, and the “hands-on” aspects of the group activities. The field trip, although optional and extra credit, was an activity students desired. Students who worked on Saturdays regretted missing the field trip and requested notification the following quarter for another opportunity to participate. Reactions to the sinkhole demonstration and other group activities are presented:

The sinkhole demonstration was particularly entertaining and presented well. (John)
I really enjoyed the sinkhole demonstration. My best friend has struggled with a sinkhole in her back yard for years. She’s already had it repaired twice and is having trouble selling her house because of it too. And she lives in Hernando County, just like you said. I’m learning so much! I’m just tickled to death! I would have NEVER thought I would like this class this much! (Terri)

A student reaction to the plastics recycling activity is presented:

I had fun learning about the plastics. Its fun learning about stuff I’ve never given a second thought to. Every night after this class, I go home and tell all of these “fun facts” to my boyfriend. He loves it. When I first started this class, I was worried I wouldn’t do so well, but it’s a blast and I think he’s happy to see me having so much fun. (Terri)

Hazardous waste activity—It made me notice all of the dangerous stuff that is in my bedroom, bathroom and garage. (Jawanda)

Anne provided her insight on the use of cute animal photos and heartwarming stories in the lecture:

How cute were those little pigs and that tiger 😊 Every week is something new and different. I really like the way we have hands-on contact with the class discussion. It gives us a different perspective on what we are learning.

Mandy and Maria shed light on the use of humor and the necessity of “going over” the homework lessons:

I enjoyed the movie on artificial grass (“The Daily Show”) as I think it added enough humor and information to make it interesting—course I think we can all agree that towards the end it was a comedy club! (Mandy)

Even though I did my homework and got it correct, I was glad you went over it because you helped me understand it more. (Maria)

**Generational Responses to the Environmental Science Course**

This section describes the results of Subquestion [SQ4]. Students’
generational responses will be discussed.

The difference in the responses of student generations became apparent during the 12-week course. Demographically speaking, most of the Millennials attended the course during the day, lived at home with parents or with a roommate/partner, and worked at least part-time. Some of the Millennials were single-mothers and frequently missed class due to lack of babysitters and transportation. Millennials missed classes for various reasons, as follows: “forgot” about school, had to work, and personal problems. Many admitted to taking anti-depressants for bipolar disease and attention deficit disorder (ADD). Students told me they either obtained a G.E.D. prior to entering college or obtained a high school diploma. Many were proud of the fact they were first in their family to enter college and had maintained a “4.0” grade point average.

The Generation X’ers, once famous for being “slackers”, appeared to be anything but slackers in the course. Most of the Generation X’ers worked full-time, maintained family and children, and owned or rented homes. A few students were ex-military and sought degrees in criminology. Some of the students were divorced or single mothers who resided at home with their parents. Generation X’ers gave various excuses for being absent: car accidents, sick in the hospital, sick child, and moving residence. The Generation X’ers suffered from problems not typical of other students. One student, Anne, was very proud of her “90-days clean” in a Narcotics Anonymous program and another had her family evicted from her home due to rent non-payment. During the classroom
breaks, students shared their stories and talked with me on the phone when I inquired about their absenteeism.

I had an interesting conversation with a parent when I called to speak to her daughter about being absent from class. When I told her mother I was concerned about her daughter’s absenteeism, she replied, “Hmm…my daughter is lying again! She lies all the time! She said her environmental class was cancelled on Monday due to an ‘environmental oil spill.’ She is 28 years old and lives here with her 6 year old daughter.” The student’s mother sounded very desperate and confided to me that her daughter was unemployed, frequently slept late, and had no real career goal. Her husband was forced to come out of retirement to pay for health insurance and support the family.

The Baby Boomers appeared articulate, conscientious, and very “gung-ho” regarding interest in the environment. They were totally immersed in the classroom experience, often bringing “loved ones” on the field trip. Most of the Baby Boomers were divorced, working men and women who needed a degree for economic purposes. The men were mostly ex-military and were likely receiving financial assistance to attend college. A couple of the married female students were raising grandchildren and occasionally missed class due to child illnesses or lack of babysitters. These remarkable women had their hands full.

All Baby Boomers were very proud to be enrolled in college and worked diligently to maintain their high grades. They excelled in classroom discussions, were not afraid to voice their opinions, and relished writing the reaction papers.
The work quality of Baby Boomers was superior to all of the generations, with Generation X’ers marking a close second place. They paid attention to detail unlike the Millennials whose term papers bore the bare minimum of pages, utilized few references, and appeared “child-like.” The topics the Millennials chose were safe and did not show individuality, like the Generation X’ers and Millennials. The Millennials often said little, if anything, of substance during the class discussions, reaction papers, and Environmental Science Inventory. Any question that required elaboration or explanation was often left blank, as they appeared non-committal and not interested in “taking a stand” on an issue.

Millennials’ most important concern in the class was the grade requirements, format of the exam, and opportunities for extra credit. Millennials did not appear to be politically savvy yet many vowed to vote in the 2006 election since they were now of age. Terri, the Generation X’er, stated in class:

I voted for President Bush because of my parents and because I am a Christian. You know, because the Church is pro-life and all.

Since taking the environmental course, she vowed that she would research each candidate and “make up her own mind.” She showed signs of reflective thinking throughout the course and questioned her entrusted authority figures.

Generation X’ers and Baby Boomers responded to the controversial issues discussed in class. They were not afraid to openly discuss the issues and showed emotion in their reaction papers. Both stated facts that surprised them
as follows: global warming ("I had heard about it but didn’t know the extent"), government-allowed testing on people, pollution in groundwater, the seriousness of the ozone’s condition, and the odorless sewage treatment plant. The Millennials were surprised about global warming, child testing, and racial and class discrimination. Millennials, especially the male students, were the only generation to write comments like “I don’t get surprised” and “I didn’t find any topics in the course to be controversial.” One sarcastic male Millennial who was studying to be a paralegal wrote, “My favorite part of class is the break. I like the discussions but the class is too long.”

Baby Boomers and Generation X'ers felt the environmental science course influenced their way of thinking. Three anonymous Generation X'ers commented on their changes of habit:

- I am more aware of what I’m doing to the environment. I certainly watch what I put down the sink!
- I try to conserve water
- I advocate more awareness pertaining to our environment.

Baby Boomers wrote of changes in philosophy and described deeper responses:

- I am revisiting a lot of these important issues (Harry)
- I’ve always been a friend to the environment but this course reinforced my beliefs. (Carol)
- I’ve become more aware of our fragile environment. (Nita)
Millennials wrote they would pay attention to environmental news in the media:

- I will now research, keep up with current events, and will try to question everything. (Lisa)
- It makes me think more about where we’ll be in 5 to 10 years from now. (Mandy)

Mostly the Generation X’ers and Baby Boomers reported feeling discomfort during class discussions. Generation X’ers listed feeling uncomfortable while discussing global warming, animal testing, and human experimentation on the underprivileged. One female Generation X’er listed feeling “uncomfortable when politics were discussed in class.” Baby Boomers were equally uncomfortable with the discussions of the government’s role in pesticide experimentation on children and animal testing. Although most Millennials did not list specific topics of discomfort, one female student wrote feeling “a lot” of discomfort regarding “government corruption” and stated “Everyone should question their motives.”

On changing behavioral habits, many Generation X’ers and Baby Boomers listed specific changes they had enacted. Some Generation X’ers listed these comments:

- As you age, you care more (Debbie)
- I changed my water usage
• I now recycle and recently created a compost pile. Also, I don’t run hot water and grease down the drain. (Sherri)

• We ride bikes instead of driving to the library and don’t run water while doing the dishes (Joy)

• I watch what I throw down the toilet and keep track of my energy consumption. (Lu)

Anonymous Baby Boomers listed these comments:

• I’m more conscious about what I buy, what I eat, and how I dispose of things

• I try to save more energy

• No more aerosol cans and no more tuna!

• I’m quitting smoking.

Millennials were not likely to comment on specific behavioral habits. Some expressed their intention to recycle, conserve water, and use natural pesticides. Some of the Millennials may live at home and are not as conscious about making changes as the mature students.

The three generations showed different preferences for the pedagogical techniques utilized during the 12-week course. Millennials were enthusiastic about working in groups with classmates. Most preferred the use of Power Point presentations or a combination of Power Point presentations and discussions. They liked printing the Power Point hand-outs for note writing. Most did not like writing notes from listening to lectures or copying material from the board.
Although they may not have actively voiced their opinions, they enjoyed listening to others. The Millennials were very receptive to the sinkhole activity (top ranked activity) as well as learning about plastics recycling.

The Generation X’ers and Baby Boomers ranked discussion format or a combination of Power Point presentations and discussion as the preferred method of instruction. Many listed the oral presentations of the newspaper articles and discussion of “current events” as their “favorite part” of the lecture. These discussions generated a lot of topics for students to share outside of the classroom. The Generation X’ers and Baby Boomers (as well as most Millennials) shared with husbands, wives, co-workers, friends, parents, or “anybody who would listen.” The Generation X’ers and Baby Boomers participated in the field trip, not only for earning the extra credit (they desire straight A’s) but to learn about science “outside of the classroom.” They appreciated the sinkhole demonstrations and “interacting with others.” Overall, the discussions were held in high regard.

Although there were few males in the classroom, especially Millennials, I observed a shared trait among those present: lack of vocal participation, a disinterest in writing reaction papers (“some days you didn’t talk about much to write on”), and lack of sharing with outsiders. Some of the male Millennials appeared to be in the class simply because it was a requirement for their degree. One male Millennial wrote, “While the instructor was very knowledgeable, the class bored me greatly.” Some of the female Millennials appeared as
disconnected as the males. One female Millennial wrote about the reaction papers, “I don’t like writing them. It’s hard for me to write what I think.” A few Millennials confessed during the 12-week quarter that although they found the class to be interesting, they had a “lot of personal problems.”

Overall, the majority of students favored writing reaction papers. Female Generation X’ers wrote these remarks:

- It was actually nice to write all the things down;
- I enjoyed it because even though I didn’t talk in class, Ms. Tabone realized I had an opinion or a thought;
- I really enjoyed them. I shared the idea with Professor Fuchs, saying he should use this idea in his class;
- It was helpful to look back and see and say how I felt about what we talked about.
- It helped a little to get things off of my mind and not to upset someone or not to air it to everyone in the class.

Baby Boomers wrote similarly, enjoying the experience of writing. The quality of writing for the Generation X’ers and Baby Boomers was sophisticated and lengthy in comparison with the Millennials. Some Baby Boomers listed these comments:

- I enjoyed writing about subjects that I feel an interest;
- It helped me focus on different topics;
• I find writing things down helps me remember what we discussed in class. I think it is a great way to see if people are paying attention!

A couple of female Millennials reported a favorable or mixed reaction, saying:

• It’s nice to do homework and know your answer is not wrong, plus it helped me retain a lot of what I was learning;

• It allowed me to express my feelings on subjects. But I didn’t always like writing them. Not much to say in some classes.

*Provoking Students’ Interest in Environmental Science*

Although not one of the research questions, a theme emerged that is worthy of discussion. Students’ interest in the environmental course was provoked by information relevant to their personal life and society. They related to science topics with real world connections and relevance to home, family, health, and safety. Figure 3 describes Provoking Interest in Environmental Science Courses and Figures 4a and 4b categorizes Topics Students Recalled During Cold Writing Sessions.

Students’ reaction papers and the cold writing exercises assisted in obtaining information pertaining to what provoked students’ interest in the environmental course. Students openly discussed their cold writing lists, developing their own categories and groupings of the types of topics they remembered. They were able to create connections between the science content delivered during the course and observations gathered outside of the
classroom. One student’s comment summed the responses, “I think that if you have more information like that [on the environment], it’s good that we know about it, because it affects all of us in one way or another.” Another student echoed the sentiment at the end of the course, saying “After taking the class, I am extremely pleased you have taught us everyday things that everyone should know.”

Figure 3. Provoking Interest in Environmental Science Courses
Figure 4a. Topics students recalled during cold writing sessions
Figure 4b. Topics students recalled during cold writing sessions
Personal Relevance to Students. Students frequently commented on enjoying the sinkhole model demonstration and the lectures that provided comprehensive information on the warning signs of sinkhole formation. Sinkhole occurrences are frequently shown in local news programs and have economically influenced the insurance industry in our home state. For this reason, there was incentive to educate oneself (and loved ones) on the sinkhole problem. Three students’ comments are presented as follows:

Learning how the sinkholes are created was an interesting experience for me. I loved that sinkhole demonstration. Ms. Tabone, now I fully understand the process of developing sinkholes. Thank you for giving information about how to detect sinkholes in homes (e.g., windows not shutting properly, trouble closing the front door, fence in the yard sinking, cracks in the walls and ceiling). Very informative and I shared with my husband!

My husband and I were watching the news and something came up about the recent sinkholes in Hernando. I was able to explain to him why some of them may be happening and just how damaging we are to our environment. It felt good and was nice to know I could teach my husband something and make him aware of the issues.

I plan on buying a house here in Florida and I was not aware of all the problems that occur [due to sinkholes].

Students’ discussions often related to their newfound awareness of environmental issues pertaining to health and safety. Popular discussion topics included the safety of well water, Teflon®, and carcinogens. Students were surprised to realize the techniques of grouper fishing and that sandwiches labeled as “grouper” may actually be a substitute fish. Students, particularly those with children, appeared attentive during the discussions. Mandy wrote about newfound information:
I knew that a person can get very ill and pass out from heat exhaustion but did not realize that a person could die from heat exhaustion. Another fact that I was not aware of was that so many people died from heat exhaustion in Europe in 2004.

Nita, a well-informed African American student in her late-forties, responded after the lecture on dioxin and her change in behavior:

I knew someone who was in the Vietnam War and he was exposed to Agent Orange or napalm. He is not right in his head to this day.

Now I am aware of reading each label of food, chemicals we use to clean my house and medicine in order to know about cautions.

Shaneka, an African-American student in her early thirties, responded to the article concerning two county workers who were arrested after pouring diesel on palm trees.

I see now that getting rid of foliage with gasoline is not such a good idea! It never occurred to me that it would affect the water.

Students articulated the content of the course linked to real world connections. Students noted observing algae in retention ponds or water-theme parks, remembering the lecture on “eutrophication.” Students shared their childhood memories of “Earth Day” after I explained the formation and history of the EPA. Lu, an Asian-American student in his mid-thirties, was interested in learning more about sinkholes because one had erupted in his neighborhood. He was a perfectionist, often typing his reaction papers and inserting graphics for emphasis. He submitted a reaction paper showing the sinkhole location and provided additional research not discussed in class.

An interesting event occurred when I read an article about a local
apartment landlord who used the homeless to remove asbestos from the
dwelling. The landlord was fined for subjecting these workers to asbestos
without the proper personal protection and informed consent. When I read the
name of the landlord and the street address of the apartment, Liz exclaimed, “Oh
my God! That is my neighbor! I had no idea! She is really rich too!” Needless to
say, this provoked a lot of discussion with the students as she proved her
acquaintance by passing around her cell phone with the neighbor’s name.

*Introduction to New Information.* Students voiced appreciation in learning
both useful, relevant information and unusual facts concerning the environment.
Toxicological trivia and personal renditions of my experiences in the wastewater
treatment field were “hot” topics listed in reaction papers and cold writing lists.
Students reported sharing trivia with co-workers, friends, and family to “impress”
and “amaze” them with their vast knowledge. Top items of interest to the
students include the toxicity of lima beans (i.e., cyanide), significance of recycling
codes on plastic products, and the presence of tomato plants near wastewater
tanks. Lisa and Jawanda reacted to recycling as follows:

> The highlight was the plastic recycling numbering system. I never really gave these symbols much thought. I knew they were for recycling but did not know what the number schemes [labels] were about. Now I do. (Lisa)

> I was very excited to learn about the different recycling codes. I never knew what the symbols marked on solid plastic items meant until now. Reading more on how recycling can reduce waste, save energy and resources. I’m glad it’s both an environmental and economic issue. (Jawanda)

Comments concerning lima beans containing cyanide and the tomato
I didn’t know too much water may be lethal! I know about drowning in pools and lakes, but drinking? Amazing! The toxicity of lima beans and salt is amazing! The absolute kicker for the night and of my 2006 was the tomato plants growing outside [the tanks] at the wastewater facilities. This just blows my mind, man. It’s probably something very small in a sense but for some reason I’m just “wowed” by this. I laugh every time I think of it. I told my co-workers about it and they were shocked too. (Terri)

I was surprised that lima beans contain cyanide. In my country, Mexico, we eat lima beans frequently and I never heard of that. (Maria)

I never would have dreamed of knowing that those are tomato vines on the sides of sewage tanks. Teaching the class the process of the growth was new to my knowledge and exciting. I couldn’t wait to get home and share it with my family. They were all shocked too! (Jawanda)

Students’ responded to new information concerning environmentally-friendly tips for energy conservation and use of natural pesticides. During the course, they realized the connection between conservation and economics, which may have served as a positive incentive for active change. Concern for indoor air quality, pesticide residue, and toxicity to children and pets, provided an incentive for students’ attention to home-use of chemicals. Kim and Julie responded to the use of safe pesticides, as follows:

I really like the ideas about the homemade pesticides—mint spray for ants. (Kim)

I knew about using the boric acid to control fleas but I was cautioned, as I mentioned in class. Getting it wet while on the floor can burn the feet of animals in the house. I honestly have never heard of the mint or cinnamon oil, but I sure will try it! (Julie)
Summary

The data gathered through students’ reaction papers, cold writing exercises, and field observations and Environmental Science Inventory were triangulated to answer the research question: “How do the students respond to controversial issues embedded in the curriculum of an undergraduate environmental science course consistent with the science education reform movement?” Subquestions emerged as the data were collected:

• Which features of controversial issues triggered responses?
• Were there signs of attitudinal changes and positive environmental actions?
• Were there any signs of skepticism and reflective thinking?
• Did generations react differently?

The Use of Controversial Issues in the Classroom Model (Figure 2) was created to show students’ responses to controversial issues embedded in the curriculum. Interpretation of the model shed insight into the elements necessary for an issue to be deemed controversial by students: injustice. The injustice is connected to aspects of inequality, intentional affliction or absence of freedom. These injustices are rooted in ignorance, greed, or neglect. Students felt particularly dissonant when these injustices affected vulnerable populations, such as children, animals, or poor/homeless.

Students showed interest in the environmental science course when topics offered value to them. Science topics related to personal relevance (e.g.,
family, home, health or safety) and societal relevance piqued their interest. Students noted real world connections of topics discussed in class, which reinforced their interest in science. Provoking Interest in Environmental Science Courses concept map was presented in Figure 3. Topics Students Recalled in Cold Writing Sessions concept map was presented in Figure 4. Students recalled topics discussed in class as follows: atrocities, environmental scares, conservation, safety, field trip, science content, environmental organizations, politics, and my personal life.

During the 12-week quarter, students were intrigued by not only useful relevant information but weird facts. They shared the topics of class discussion with loved ones, colleagues, and friends to “inform and impress.” Students attended the class field trip to a reclaimed water facility (wastewater treatment plant) with loved ones and “significants” to share the educational experience.

Many students who entered the course with a preconceived notion of boredom or fear of science showed signs of attitude change. Students sought further information on lecture topics, discussed lectures with outsiders, practiced environmental conservation at home, joined environmental organizations, and vowed to become politically active (e.g., voting, signing petitions).

Students developed signs of reflective thinking as the course progressed. They began showing skepticism, questioning sources of print and broadcast media. As Terri wrote, “I need to keep an open mind during this course” despite her self-proclaimed “ignorance of the issues” and conservative upbringing. She
stated, “It’s not my practice to question everything but it could pay off if I did questions things.”

Not all students kept an open-mind during the 12-week session. There were students who did not report responses to controversial issues. Students with known conservative attitudes reported cognitive dissonance to discussing politics in an environmental science course.

Students enjoyed the discussion format which offered them a voice in class. Those who were too shy to contribute to the open forum appreciated the opportunity to vent in the reaction papers. Students like Baby Boomers and Generation X’ers favored the discussion format or a combination with Power Point presentations. Foreign students, Baby Boomers, and Generation X’ers wrote reaction papers a chalkboard driven lecture on ecosystems. They responded favorably to the traditional method which requires note copying and references specific page numbers in the book. Millennials were not keen on discussions or writing their feelings on paper. They enjoyed group activities and demonstrations. All generations reported enjoying the sinkhole demonstration and plastics recycling activity. Overall, the Baby Boomers and Generation X’ers produced better quality reports, showed enthusiasm in the course, and implemented conservation and environmentally-friendly activities.
Chapter Five—Discussion, Conclusion, and Recommendation

Introduction

The purpose of my study was to describe the ways non-science majors in an undergraduate environmental science course responded to controversial issues embedded in the curriculum of a course consistent with the science reform movement. Using a phenomenological approach, students’ experiences during the 12-week course in Summer 2006 were explored to describe the phenomena. Data was analyzed from classroom observations, students’ weekly reaction papers, cold writing sessions, and Environmental Science Inventory.

Through the data analysis process, themes emerged. Students were disturbed by the discussions of controversial issues and signs of cognitive dissonance developed. Students reacted to controversial issues related to justice. Belief in Just World influenced students’ perceptions, including those of all political leanings. Some students grew in critical thinking, displaying reflective thinking thought patterns. Some students resisted attitudinal and behavioral changes. Students’ interest in the environmental science course was provoked, particularly if deemed personally relevant. The multiage composition of the class influenced students’ generational responses to the environmental course.

Students’ Responses to Controversial Issues

Cognitive Dissonance. Students responded to the controversial issues
embedded within the environmental science curriculum according to students’
reaction papers, cold writing exercises, and Environmental Science Inventory.
Approximately 41 percent of students reported feeling conscious emotions
ranging from mild to strong dissonance, as described in Figure 1, Use of
Controversial Issues in the Classroom Model. The emotions appear associated
with bioethical situations described during the discussion portion of the lecture.
Topics that appealed to students’ emotions related to vulnerable populations
(e.g., children, animals, and poor/homeless). Observations of the class
discussions and comments in reaction papers showed feelings of dissonance
regarding human experimentation without consent or full-disclosure. In addition,
cases of vulnerable populations suffering known exposures to contamination
without remediation or personal protection disturbed the students. They
expressed feelings of shock and disbelief toward authority figures and institutions
that condoned these practices.

Students reported during the 12-week quarter feelings of anger, disbelief,
amazement, and sadness. Mid-way through the course, students confided,
“Every time I leave this class, I feel depressed. I feel angry about what I am
hearing and depressed at the same time.” For this reason, at the sixth class
meeting I gave my “Lecture of Hope.” Students appeared relieved when we
discussed “What we citizens can do to change the status quo.” This provided an
opportunity for me to address the question asked by students during the quarter,
“How can I get involved?” The “Lecture of Hope” offered students a positive
viewpoint and hope for the future of the environment.

The Use of Controversial Issues in the Classroom Model (Figure 2) addressed the question, “What makes an issue controversial?” The dictionary defines “controversy” as a dispute or debate, especially a lengthy and public one, between sides holding opposing views ("The American Heritage Illustrated Encyclopedic Dictionary," 1988). According to the emergent model, a controversial issue must have an element of injustice to affect a student’s moral code or value system, causing feelings of cognitive dissonance. An issue may be deemed controversial if the injustice concerns inequality, absence of freedom, or intentional affliction or abuse. If a controversial issue “does not sit well” with a person and dissonance occurs, a motivation within the person pushes its reduction through self-rationalization or overt demonstration against the dissonance (i.e., actions) to create consonance.

Students responded to the newspaper articles and personal stories related to the Stuckey’s and Brooksville contaminated sites because both related to environmental justice. In particular, the Brooksville contaminated site appeared as a case of environmental racism. Most of the victims were African-American residences who have suffered consequences allegedly from the neighboring Public Works Facility. The Stuckey’s story hit students’ heartstrings based on the presence of children consuming the benzene contaminated groundwater. The governmental agencies have refused to treat the contaminated groundwater at Stuckey’s since the benzene levels are have not exceeded State and Federal
Drinking Water Standards (the benzene levels are slightly below the Maximum Contaminant Level). When I performed the environmental project, the agencies had neither sampled the onsite potable well in three years, nor warned the tenants of the contamination. Students noted that “greed” was the culprit behind the atrocities and injustices committed. It appears that injustices rooted in greed, neglect, or even ignorance served as a catalyst for cognitive dissonance responses in students.

*Justice.* The element of justice is the basis for students to deem an issue controversial. This connection is supported by Lerner’s “Belief in Just World” (BJW) theory (Lerner, 1965, 1980, 1997, 2003; Sallay & Dalbert, 2004). During the class discussions of bioethics, a student may suffer cognitive dissonance based on the unfairness and injustice of the situation. Those with high degrees of BJW feel that everything in life is predictable, controllable, and people get in life what they deserve. In other words, “what comes around goes around.” Lerner reasoned that people have a need to believe the world is just; innocent suffering threatens this belief because it suggests that there are people who do not reap their just desserts. To protect BJW, a victim can be compensated for unjust treatment. (Hafer, 2000, p. 1059).

Lerner’s BJW theory appears applicable when students described their desire for punishment of perpetrators of injustice. Students reported that victims of environmental justice or racism should be compensated and perpetrators should be punished. As “John” a male in his mid-thirties noted, punishment should be “to the fullest extent of the law.” The purpose of punishing the
offending party is not solely for the purpose of making the victim feel better, but provides a societal requirement for retributive justice (Darley, 2002).

According to Hafer (2000), if the compensation does not occur or cannot occur, people may respond defensively toward the victim’s character. During a class discussion, some students in class berated the parents who accepted the $970 for using their children in the CHEERS Pesticide study, without blaming the EPA. Particularly notable in the classroom was “Robin” and ex-military students who felt human experiments, whether on children or a result of war, provided important information. Robins stated, “As inhumane as it appears, we (society) learn from these experiments!” It is likely that Robin harbored a worldview entrenched in BJW. She and Julie parroted conservative rhetoric during class discussions and in reaction papers.

Conservatism, Belief in Just World, and Cognitive Dissonance. Dittmar and Dickinson (1993) studied 98 female and 80 male college students at the University of Sussex, segregating them according to political orientation (right-wing, moderate/liberal, and left-wing). The students filled a “Social and Political Attitudes Questionnaire” and researchers measured their BJW scale. After MANOVA analysis, the results showed a significant effect for political orientation, F(10,326)=13.61, p<0.0001 and post hoc comparisons (Scheffe, p<0.05) showed the three means of the political groups significantly differed from each for Traditional Moralism, Machiavellian Cynicism, and New Left Philosophy. As predicted, a strong main effect for political orientation, F(2,161)-19.08, p<0.0001
showed right-wing subjects endorsed just world beliefs strongly, followed at some distance by moderate students, and with a more substantial gap by left-wing participants (Dittmar & Dickinson, 1993).

Furnham (2003) agrees with Dittmar and Dickinson’s results, noting BJW scores are associated with those favoring right-wing socio-political beliefs. In addition, the students were not actively involved or interested in politics. Furnham’s review of BJW literature over the last ten years noted most studies show BJW associated with conservatism and authoritarianism. He cites:

> If one assumes the world is just, there must be less reason to attempt to change it through political action than if one believes it is fundamentally unjust. (Furnham, 2003, p. 810)

Students’ reactions to learning about science atrocities and injustices described feeling sad, angry and shocked. Reflecting upon the data descriptions, although traces of empathy emerged, the writings appeared in line with justice psychology. Empathy and justice differ in the temporal durability of effects, with empathy being relatively short-lived (Blader & Tyler, 2002). Justice concerns regard groups of people, not individuals, and may have long-term effects. The need for equilibrium is strong and people in disequilibrium strive for justice. People attempt to “make things right” to alleviate the nagging feelings of injustice, similar to cognitive dissonance. For this reason, BJW may be serve as motivational in origin, promote self-efficacy, and hope for a just world (Furnham, 2003). Those with low levels of BJW believe they can restore justice and help victims, promoting altruistic behavior.
A dimension of Lerner’s BJW theory relates to social justice advocacy on behalf of oppressed populations. The dimension assumes that an individual has concern for members of his/her own moral community, excluding fair treatment to others. A study of 222 social work students enrolled in a course on oppression showed that those who believed in a just world suffered higher distress in relating to the topic of oppression and engaged in fewer advocacy levels (Van Soest, 1996).

The students enrolled in the environmental science course showed a multicultural span of demography. Students demonstrated a variety of lifestyles (e.g., gay, single-parent, living at home, etc.), socioeconomic statuses (e.g., middle-income, low-income), employment statuses (e.g., employed, unemployed, ex-military), and ethnicities (e.g., Caucasian, Asian, African-American, and mixed races). With a mixed backgrounds group, it is highly likely most had experiences with injustice and discrimination in the world, lowering their belief that the world is just. In other words, students enrolled in the study were inclined to respond to the controversial issues and stories of bioethical atrocities. This sensitizes them to the belief “life is not fair” and may play a role in motivating their involvement in environmental advocacy.

Another important observation noted by conservative students is they described great discomfort during class discussions but still held firmly to their beliefs. “Julie,” the soft-spoken conservative student wrote in the Environmental Science Inventory that her “beliefs are now reinforced.” Observing the data that
emerged during the study, most students were positively influenced by embedded controversial issues in the curriculum. The exceptions to the rule, conservative students, are actually supported by a facet of Festinger’s (1956) early cognitive dissonance work described in his book “When Prophecy Fails.” Festinger and his colleagues studied a small cult-following of a Mrs. Marian Keech, a housewife who claimed to receive messages from aliens via automatic writing (Festinger, Riecken, & Schachter, 1956). The message of the aliens was one of a coming world cataclysm, similar to the millennial or messianic movements who prophesize the end of the world (e.g., Y2K’ers). Festinger noted in his study that when a person with deep convictions is confronted with information disconfirming his/her beliefs, he or she actually clings to the belief (Festinger, 1989; Festinger et al., 1956). He notes that it is less painful for a person to tolerate the dissonance than discard the belief (even if flawed or disproved) admit he or she was wrong. He lists the five conditions necessary for the phenomenon to occur:

1. There must be a conviction.
2. There must be commitment to this conviction.
3. The conviction must be amenable to unequivocal disconfirmation.
4. Such unequivocal disconfirmation must occur.
5. Social support must be available subsequent to the disconfirmation. (Festinger et al, 1956, P. 216)

In the case of Julie, she claimed she was a registered Democrat yet declared her great distrust of former Democratic candidates, John Kerry and John Edwards; described her disdain for politics and stated her discomfort with any political discussions held in class; and cited her husband’s denial of the
existence of global warming. Although Julie listened to the discussions and lectures during the quarter, she admitted speaking with her husband after each class. Her husband, who serves as her authoritative figure (reflective thinking) and social support, likely relieved her dissonance by discounting the scientific and factual evidence disseminated in the lectures.

*Reflective Thinking.* Students showed signs of reflective thinking by the end of the 12-week course. Many entered the environmental course with no preconceived idea of what it entailed. In fact, students described fear of science and anticipation of a “boring science class.” According to students’ writings, the class was an “eye-opening” experience and they pursued interest beyond the classroom. Students began reading outside of the classroom and brought in newspaper articles they encountered. Students reported they looked at the sources of news articles and the funding source of research studies to search for bias.

They began to question their long held beliefs and thinking patterns as skepticism developed. “Terri,” clearly held a pre-reflective thinking pattern upon entering the course. She confided to being ignorant of environmental issues and politics. She admitted to voting according to what her parents and minister recommended during the 2004 election. As the course progressed, her detailed reaction papers showed signs of reflection, skepticism, and the wanting for knowledge and evidence. She vowed to be informed on issues and candidates’ platforms concerning environmental issues prior to voting in the mid-term
election. “Terri” was showing signs of quasi-reflective thinking patterns.

She was the only student who was able to see “An Inconvenient Truth” prior to its departure from town. After seeing the movie, she jumped onto the global warming bandwagon. During a class break, Terri told me she was arguing with a co-worker about the existence of global warming. She presented a list of points she discovered while researching her term paper on polar bears.

“Terri” was not the only student to show clear changes. Due to the political nature of the course, students reacted to the ongoing conflicts in the Middle East and the topics of Gulf War Syndrome and depleted uranium. “Kelly” stated that her brother served in the Gulf War and Iraq Conflict. He lives in Colorado and is suffering from unknown debilitating ailments. During the duration of the course, she researched Gulf War Syndrome. She said, “I want answers!”

The operation of reflective thinking includes subprocesses, such as a) a state of perplexity, doubt and b) an investigative search toward bringing to light further facts that serve to support or nullify a belief (Dewey, 1933). Students reported enjoying listening to class discussions to not only “hear other’s opinions” but also express their own. Review of the reaction papers and observations of the class discussions showed students were thinking and assimilating new information.

The conservative students in the environmental course described feelings of cognitive dissonance during discussions, particularly those connected to
politics. Even though the cognitive dissonance may not have motivated a higher reflective thinking stage, thinking was happening. This is a step forward. Dewey (1933) referred to reflective thinking and cognitive dissonance (although the theory had not been formed at that time), when he wrote:

Reflexive thinking is always more or less troublesome because it involves overcoming the inertia that inclines one to accept suggestions at face value; it involves willingness to endure a condition of mental unrest and disturbance. Reflexive thinking, in short, means judgment suspended during further inquiry; and suspense is likely to be somewhat painful. (p. 13)

*Attitudes and Behavioral Change.* Many students who entered the course with a preconceived notion that “science is boring” or harbored a fear of science showed signs of attitude change. As the environmental course progressed, students reported their desire to influence friends, family, and co-workers to participate in environmentally-friendly practices. They became interested in seeking information concerning environmental issues and conservation *beyond the classroom.* Students reported paying attention to news reports on global warming and reading the newspaper for environmental science news. Students reported signing online petitions regarding house bills to save endangered animals (i.e., wild mustangs) and prevent oil drilling in Florida’s gulf. A few of students joined environmental activist groups like Sierra Club by the end of the 12 week quarter. Anne, who recently recovered from narcotics addiction, proudly exclaimed in class, “I joined ‘Save the Mustangs’ and ‘Save Keiko the Killer Whale.’” “Anne” told me she related to the plight of animals based on her own personal struggles.
Three students voiced wanting to enter environmentally-related work fields or majors of study. Using energy saving, water conservation, and recycling practices became popular behavioral changes. Students may have connected the fact that conserving resources and recycling increases monetary savings. Students reported their intentions to try safer pesticides substitutes (e.g., mint oil spray, boric acid mixture) to reduce pesticides residues in the environment. Awareness of hazardous wastes and disposal of grease into wastewater systems were reported by several students (especially by those who attended the field trip).

The incentive to participate in environmental advocacy was prompted by enrollment in the environmental course. Students who reported feelings of disturbance and dissonance desired to “help in some way.” Whether prompted by cognitive dissonance or a sense of societal duty, students were interested in helping the world.

Provoking Students’ Interest in Environmental Science

All degree-seeking students are required to enroll in the environmental science course. Students reported they were “pleasantly surprised” at “how interesting” the course was, contrary to their initial expectation. As students progressed through the course, they reported enthusiasm and “eye-opening” experiences along with their encounter of cognitive dissonance. Students shared the topics of class discussions with friends and loved ones, extending their classroom experience to their personal world. This served as a venting
mechanism and evolved into a form of advocacy as students informed loved ones of issues relevant to society (see Figure 3). Students relayed information by educating their family and friends on topics having value or personal significance.

According to data derived in cold writing sessions, students valued topics that were practical to their health, family, and home life. Students made connections between science content discussed in lectures and real world situations. Value and relevance are the keys to student interest in environmental science (see Figure 3). In addition, cold writing sessions indicated the types of topics students were able to retrieve from memory, hence, revealing relevance. Figure 4 illustrates a list of discussion and lecture topics students recalled from memory. Students remembered environmental science content and related to local geography (e.g., sinkholes, drilling in Florida’s Gulf). Students related to local moral and bioethical issues (e.g., Jacksonville pesticide study, Stuckey’s groundwater contamination, Brooksville Public Works site). A student Julie said in a class discussion, “I drink well water at home and live next to a gas station. Now I wonder about the safety of my drinking water.”

A student named Robert said, “When I bought my home, it never occurred to me that my drinking water may not be safe. Thanks for telling us about these problems.”

Students recalled the “bad things” we discussed in class, Kristin said describing her experience. After the cold writing session, students created
categories and I drew a map on the board. Students who participated in the field trip listed topics relevant to the excursion to the wastewater plant. Regarding science content, students often listed items relevant to their home state, such as eutrophication, sinkholes, ozone, and groundwater pollution. High on the popularity scale were listings of group activities: sinkhole demonstration, plastics recycling activity, and household hazardous waste activity. Even though the controversial issue did not provoke empathy or emotion, the justice issue of “owning a plastic lawn” was a popular topic of discussion.

Students reported political topics, such as voting, the war, EPA, and Bush Administration on their cold writing lists. Students recalled the health and environmental effects associated with the atomic bombs, Lebanese oil spill, Agent Orange, depleted uranium, especially the birth defects. Animal testing, toxicology, and lethal doses of common substances affected students (e.g., lima beans and cyanide). Students recalled details about my personal life during the cold writing sessions: anti-war activism, public access talk show, and my boyfriend’s election for Congress. A few students recalled the humorous animal photos I embedded within the slide presentations to enliven the lectures. Students recalled environmental scare stories (e.g., Cranberry Scare, asbestos) and oddball trivia (e.g., tomato plants growing outside wastewater tanks) associated with environmental science. Students were very interested in history and trivia, often exclaiming, “I didn’t know that! I never learned that!”
Generational Responses to the Environmental Course

The composition of the environmental class was notably multicultural in relation to age differences. The traditional-age (Millennial) students and non-traditional age students (Generation X’ers and Baby Boomers) responded differently in the environmental course. The mature students showed more desire to learn, participation in class discussions, high quality of writing in term papers, and increased awareness and skepticism of government and corporate entities. The mature students showed a strong work ethic and enjoyed writing the reaction papers. The quality of their term papers was richer and showed a level of pride. They preferred the lecture delivery via discussion format or a combination of Power Point presentations and discussion. Some mature students actually preferred the traditional board methods so they could see and write the notes.

Generation X’ers and Baby Boomers were very interested in learning about the environment, paid attention in class, and admitted to change in environmental attitude and behavior. They were concerned about the future of the planet for their children and grandchildren and understood the politics behind the environment. They did not seem surprised or shocked about the government’s involvement or lack of involvement concerning people’s exposure to environmental contamination.

What I discovered during the study is Howe and Strauss’ research on generations appeared off base or outdated. Their first book “Generations”
appeared in 1991 and subsequent books on Millennials appeared in 2000. Their labeling of Generation X’ers as a “slacker” or “whatever” generation appears untrue by today’s standard. Generation X’ers are mature, dependable, law-abiding citizens who care about their future. From my observations in the environmental course, the Millennials appear sheltered, clueless, uninvolved, and afraid to own an opinion. The exception to this opinion was my observations concerning African-American students. Shaneka noted, “My opinion mattered.” The African-American students, especially the females, actively participated in discussions and wrote heart-felt reaction papers. Most offered an opinion during discussions, especially the female students. They lived at home and relied on their parents’ gratitude for living expenses. They did not worry about their future.

Oblinger’s (2003) description was consistent with my data when he noted Millennials’ preference for group activities, identification with parents’ values, fascination with technologies, and racial diversity. According to Blackhurst and Foster (2003), the Millennials have faith in the government and institutions. Some of the aforementioned characteristics may actually be true of every new rising generation. As “Debbie,” a Generation X’er, stated in a reaction paper “As you age, you care more.” Possibly some of Howe and Strauss’ notations concerning generations are not unique to specific generations but are typical of every new generation.

I did notice Millennials’ lack of interest in citizenship and environmental political involvement, although some 18 year old students were interested in
voting. This contradicts Howe and Strauss’ declaration that Millennials are civic-minded (Howe & Strauss, 2000). The Millennials appeared to be grade conscious and appreciated a detailed syllabus. They inquired about extra credit opportunities (rarely taking advantage of them), turned in papers late, and seemed carefree about the college experience. Millennials, as well as other generations, were comfortable communicating through email. Some Millennials showed little respect for authority as described in email communications.

Regarding the lecture delivery method, they enjoyed the use of Power Point presentations due to convenience (hand-outs versus note writing) videos feeding their need for visual stimuli.

Millennials appeared more interested in their social life, employment, and home lives than school achievement. Absenteeism was prevalent. During the class, some Millennials would lay their heads on desks in boredom. The Millennials appeared as the “Generation X’ers” described in Howe & Strauss’ books.

*Implications to Undergraduate Science Education*

The research study embedding controversial issues within an environmental science course shed light on the elements necessary for an issue to be deemed controversial by students. Some science education researchers examine the influence of STS issues in science curriculum and measure students’ responses to researcher-scripted dilemmas. The scripted dilemmas are assumed to be controversial, thus, affecting students’ values. However, from
my experience, researcher scripted dilemmas may lack the necessary element for controversy—injustice. Issues of injustice, especially with cases of abuse, inequality, and absence of freedom of vulnerable populations, affect cognitive dissonance.

In addition, the research study duly supported Festinger’s theory of cognitive. Cognitive dissonance served as a motivator for students with an open-mind toward environmental science, enabling the possibility of reflective thinking. Conservative students’ with deep convictions reacted to the controversial issues by clinging to their beliefs, even in the face of evidence. Those students reinforced their pre-reflective thinking with social reinforcement from authoritative figures (e.g., husband, parents).

This aspect is particularly useful to science education researchers in respect to the controversy surrounding the teaching of Creationism alongside Evolution. According to Festinger’s theory, students with weak or moderate religious convictions may be more accepting to scientific theories. They are likely to react positively and accept new information, using reflective thinking pathways. On the contrary, students with deeply held religious convictions may actually adhere tightly to their beliefs, even in the presence of irrefutable scientific evidence. Their deeply held convictions will be reinforced through their social system (e.g., family, ministers), resulting in refusal to accept scientific proof. It is often easier for a person to deal with cognitive dissonance in the face of evidence than break away from family tradition or “groupthink” opinion.
Students are often criticized as not being critical thinkers or having an opinion. In the traditional teacher-centered classroom setting, students typically watch Power Point presentations, listen to lectures, and copy board written notes with the intention of passing a mid-term and final exam. Normally a technically written term paper provides additional grade assessment.

Students are unable to provide evidence of original thought and critical thinking if a course does not encourage discussion. Often the discussion format in college courses is offered at the graduate level. The research study showed undergraduate non-science majors benefited from a public forum and the opportunity to maintain a diary of opinions in the form of reflective essays. This provided an opportunity for analysis of conflicts and synthesis of newly formed ideas. Using the reactions papers in the environmental science course served as a tool to recall topics discussed in class and reinforced reflective thinking. Overall, using reflective writing exercises as a learning method are beneficial to both students and researchers.

Non-science majors are often intimidated by the thought of taking a science course and do not understand its relevance to their desired major. The environmental science course I created engaged students in both science content and its practical applications to everyday life. Students drew connections between the science content, developed an extended interest in environmental science, changed home behavioral habits, and shared their newfound interest with loved ones. The course evolved into a “family experience” since students
shared information learned with sons, daughters, and friends. Students invited significant others to the class field trip. The environmental science course was truly a community experience.

The elements of the science reform movement came into fruition as students used cooperative learning and developed an understanding of the connections and complexities of ecological systems, understood the personal and social perspectives of environmental science, and the history and nature of science. In addition, the environmental course promoted civics and government, the roles of citizens in American democracy, and offered solutions to citizen participation.

Lastly, the research study provided information not only to science education researchers but those involved in science communications. Media moguls often wonder what kind of television programs entice viewers to “want to know more.” They may possibly wonder, “What kind of science news provokes the general public?” The study enlightened scientific journalists or communication specialists on techniques to interest the general public (i.e., non-science majors) in science issues.

**Recommendations for Further Research**

Future studies on students’ response to embedding controversial issues within the environmental science curriculum may examine case studies of students. A few articulate students may be followed through the course. One-on-one interviewing may assist the researcher in probing specific research
questions as they emerge. After the course has terminated, follow-up interviews may reveal additional useful information. An interesting twist may be to interview family members or significant others to evaluate attitudinal or behavioral changes associated with the course. This may assist in confirming self-reported data.

Diverse character studies may assist in delving further into specific themes that emerged. For example, a character study may be performed on a student with strong conservative political leanings, particularly a military background. A student with open-minded progressive leanings provides a contrast. Another research combination may be to examine the generational differences in-depth by studying a Millennial, Generation X'er and Baby Boomer. The multi-cultural ethnic and race aspect may provide further insight into the cultural responses at work. The various blends of character studies are important to future science education research in using controversial issues in undergraduate science courses.

A science education researcher may implement a curriculum similar to the dissertation research study, evaluating the responses to the students. It would be fascinating to examine generalization of the techniques or topics used in the course. A researcher in another region of the country may have to tweak the science content (e.g., study of sinkholes) relating to local interests of the students. Local environmental contaminant problems and bioethical issues may strengthen students’ responses.
Future studies may further examine the generational responses to science reform methods in an undergraduate science course. Responses to the lecture methods, including the use of discussion, may be an area of interest. Since science instructors’ intentions are to reach all students in the class, this area of research is significant to the mixed-age audience often observed in today’s colleges and universities.

Conclusion

Overall, the students appeared responsive to the controversial issues embedded in the environmental course. They appeared to enjoy the use of reform methods in course, including use of open discussion format, cooperative learning, field trips, classroom demonstration, and various media (e.g., videos, documentaries). The study showed the use of controversial issues in the environmental science course stimulated reflective thinking and encouraged the expression of environmental advocacy beyond the classroom.

Students expressed participation in energy and water conservation, recycling practices, political involvement, and joining environmental groups. Students shared information with outsiders, such as family, friends, and co-workers when they deemed it personally or societally relevant (e.g., pertaining to family, health, safety, homelife, politics).

Generational differences in students were observed in their openness to discuss controversial issues, ability to self-express, attitude toward the environment, quality of writing, and involvement in the educational process. The
Generation X'ers and Baby Boomers appeared to be very interested in learning about the environment, paid attention in class, and admitted to change in environmental attitude and behavior. Most of the Millennials appeared as quiet, self-absorbed students more interested in grades and their social life than citizenship and activism.
REFERENCES


BIBLIOGRAPHY


CITED LYRICS

1. t’Ai’nt What You Do (It’s the Way That You Do It) by Ella Fitzgerald
2. Everything Old is New Again by Peter Allen
3. It don’t mean a thing if it ain’t got that swing by Ella Fitzgerald
4. Trouble in mind and I’m blue by Richard Jones
5. Heat Wave by Irving Berlin
7. Thinking Blues by Bessie Smith
8. Accentchuate the Positive by Johnny Mercer
9. Flying Saucer the 2nd by Buchanan and Goodman
10. 2525 (Exordium and Terminus) by Zager and Evans
11. Keep on Eating by Memphis Minnie
Appendix A: Course Syllabus

COURSE OUTLINE
Environmental Science SCI 1001

| Week 1 | Lecture: Chapter 1—Introduction, history of environmental science and notable environmental disasters
|        | Assignment for Week 2: Read Chapter 7 and 8
|        | Chapter 7 Water: Hydrologic Cycle and Human Use
|        | Chapter 8 Soil: Foundation for land ecosystems
|        | Homework—Reading and assigned questions

| Week 2 | Discussion and elaboration of reading assignment and student homework.
|        | Lecture/Discussion: Hydrologic cycle
|        | In class demonstration: Sinkhole model
|        | Assignment for Week 3: Read Chapter 17 and 18
|        | Chapter 17 Water: Pollution and Prevention
|        | Chapter 18 Municipal Solid Waste: Disposal and Recovery
|        | Homework—Reading and assigned questions

| Week 3 | Discussion and elaboration of reading assignment and student homework.
|        | Lecture/Discussion: Water pollution and solid waste
|        | In class demonstration: Solid waste
|        | Writing Project 1—Student will choose a current event in the news based on the topics explored thus far, and research the topic in greater depth and write a 3 page minimum report outlining the news coverage of the topic. The report is due WEEK 5.
|        | Assignment for Week 4: Read Chapter 19
|        | Chapter 19 Hazardous Chemicals: Pollution and Prevention
|        | Homework—Reading and assigned questions

| Week 4 | Discussion and elaboration of reading assignment and student homework.
|        | Lecture/Discussion: Hazardous waste
|        | In class demonstration: Hazardous waste
|        | Assignment for Week 5: Read Chapters 15 and 16
|        | Chapter 15 Environmental Hazards and Human Health
|        | Chapter 16 Pests and Pest Control
|        | Homework—Reading and assigned questions
### Appendix A (Continued)

<table>
<thead>
<tr>
<th>Week</th>
<th>Discussion and elaboration of reading assignment and student homework.</th>
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<tbody>
<tr>
<td></td>
<td><strong>Lecture/Discussion:</strong> Environmental health and pesticides</td>
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<td><strong>Assignment for Week 6:</strong> Read Chapters 20 and 21</td>
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<td>Chapter 20  The Atmosphere: Climate, Climate Change, and Ozone Depletion</td>
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<td>Chapter 21  Atmospheric Pollution</td>
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<td>Homework—Reading and assigned questions</td>
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<td><strong>Writing Project 1 due</strong></td>
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<tr>
<td>Week 5</td>
<td>Discussion and elaboration of reading assignment and student homework.</td>
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<td><strong>Lecture/Discussion:</strong> Atmospheric pollution, global warming</td>
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<td><strong>Writing Project 2</strong>—Student will choose a current event in the news</td>
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<td>based on the topics explored thus far, and research the topic in</td>
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<td>greater depth and write a 3 page minimum report outlining the news</td>
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<td>coverage of the topic. The report is due WEEK 7</td>
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<td><strong>Assignment for Week 8:</strong> Read Chapters 2--4</td>
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<td>Chapter 2  Ecosystems: What They Are</td>
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<td>Chapter 4  Ecosystems: How They Change</td>
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<td>Homework—Reading and assigned questions</td>
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<td><strong>Writing Project 2 due</strong></td>
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<tr>
<td>Week 6</td>
<td>Discussion and elaboration of reading assignment and student homework.</td>
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<td><strong>Lecture/Discussion:</strong> Ecosystems</td>
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<td><strong>Assignment for Week 9:</strong> Read Chapters 12—14</td>
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<td>Chapter 12  Energy from Fossil Fuels</td>
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<td>Chapter 13  Energy from Nuclear Power</td>
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<td>Chapter 14  Renewable Energy</td>
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<td>Homework—Reading and assigned questions</td>
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<td><strong>Writing Project 2 due</strong></td>
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<tr>
<td>Week 7</td>
<td>Discussion and elaboration of reading assignment and student homework.</td>
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<td></td>
<td><strong>Lecture/Discussion:</strong> Fossil fuels and energy</td>
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<td><strong>Assignment for Week 10:</strong> Read Chapters 22 and 23</td>
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<td>Chapter 22  Economics: Public Policy, and the Environment</td>
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<td>Chapter 23  Sustainable Communities and Lifestyles</td>
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<td>Homework—Reading and assigned questions</td>
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<tr>
<td>Week 8</td>
<td>HOLIDAY – No class</td>
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<tr>
<td>Week 9</td>
<td>Discussion and elaboration of reading assignment and student homework.</td>
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<td><strong>Lecture/Discussion:</strong> Fossil fuels and energy</td>
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<td><strong>Assignment for Week 10:</strong> Read Chapters 22 and 23</td>
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<td>Chapter 23  Sustainable Communities and Lifestyles</td>
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<td>Homework—Reading and assigned questions</td>
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Appendix A (Continued)
| Week 10 | Discussion and elaboration of reading assignment and student homework.  
**Lecture/Discussion:** Economics and sustainable communities  
Homework—Assigned questions  
Clear Lake Activity and video |
|---------|------------------------------------------------------------------|
| Week 11 | Discussion of current events  
**Review for Final Exam** |
| Week 12 | **FINAL EXAM** |
APPENDIX B: Course Curriculum

Week 1

Topics
Introductory lecture—History of environmental science and environmental scares, including “Cranberry Scare”, cyclamates, saccharin, Times Beach, Love Canal, Asbestos in hair dryers, Earth Day, formation of EPA, Three Mile Island, Alar. Also, Chapter 1—What is a theory, pseudoscience, Easter Island Have/Have Not Story”

News Articles Discussed
EPA Encouraging Pesticide Companies to Conduct Human Studies,” by Public Employees for Environmental Responsibility; “Stop Human Pesticide Testing” by pacforachange.com; “Plans to Test Anthrax Vaccine on Children Criticized” in “Tampa Tribune” dated 7/16/05

Activity
None

Week 2

Topics
Water: The Hydrologic Cycle and Human Use—special emphasis on sinkhole formation
Soil: Foundation for Land Ecosystems

News Articles Discussed
**Special ethical case**—Discussed former Stuckey’s project in Punta Gorda, Florida

**Activity**
- Sinkhole model

**Week 3**

**Topic**
Solid Waste and Water Pollution

**New Articles Discussed**

Follow-up on plastic grass story—Letter to the editor “This Grass is Bad News” in “St. Pete Times” dated August 6, 2005;

Read Sierra Club’s newsletter discussing the logging of the redwood trees in the Giant Sequoia forest;

Also discussed the Bush Admin. Approval of dynamiting the Everglades for limerock;

Put website address on the board for Sierra Club

**Activity**
- Group activity concerning plastic recycling items and numerical nomenclature system
- Handout: Voting History of FL House & Senate Reps
Appendix B (Continued)

Week 4

**Topic**
Hazardous Waste

**News Articles Discussed**

**Activity**
- Group exercise: hazardous wastes in the home
- Handout: geological cross-section and groundwater direction map from contamination assessment report

Week 5

**Topics**
Pests and Pesticides; Risk and Health Hazards

**News Articles Discussed**
“Indictment Says Homeless Duped to Strip Asbestos” dated April 25, 1998 in LA Times; “Cases of fabricated medical data on rise” dated July 10, 2005 in “St. Pete Times”; “Homeless Removed Asbestos” dated February 8, 2004 in “Tampa Tribune”; Info on Stauffer Chemical Co., Superfund site in Tarpon Springs, Florida (USEPA website); “Stauffer health studies are reason for concern” dated...
Appendix B (Continued)


Activity
- PBS Video “Bill Moyers NOW” on Global Warming
- Handout: Common Carcinogenic Hazards from Ames, B.N. and 1983/Ames et al.,1987

Week 6
Topics
Atmospheric Pollution and the Atmosphere: Climate, Climate Change, and Ozone

News Articles Discussed
Theme of class is “Hope”: Read from “50 Ways You Can Love Your Country” by Move.org

Activities
- Video: “Daily Show” segment about plastic lawn in St. Petersburg, Florida (August 2005); segment on Hurricane Katrina, Mardis Gras (March 2006) and Pinellas County’s “South Cross Bayou” video
- Hand-out: Global warming map “Feeling the Burn” from “Mother Jones”, May/June 2005 and “Global Warming Fast Facts” by Brian Handwerk, “National Geographic News”

Week 7
Topics
Ecosystems (board driven lecture)

New Articles Discussed
“New study explores spectrum of travel-related illnesses” dated February 28, 2006 in “St. Pete Times”; “Pride and prejudice are preventing health care reform” (Paul Krugman) dated February 2006 in “New York Times”; “Food Safety First” dated March 2, 2006 in “St. Pete Times”; “Feds May Remove Some Food Warning Labels” dated March 2, 2006 (AP); “Antarctica’s ice melts faster than snowfall can replace it” dated March in “Los Angeles Times”; Listed statistics on
GOP and George Bush

Activities
- Video segments from National Geographic Channel Video Library (e.g., wind power, Florida panther, Lyme disease, aquaculture, flood control in Netherlands)

Week 9

Holiday—I emailed articles to read about global warming, HR503—House Bill concerning wild mustangs, air shooting of wolves in Alaska, and a list of environmental organizations (e.g., Sierra Club, Environmental Defense Fund)

Week 9
Topics
Fossil Fuels
New Articles Discussed

Week 10
Topics
Economics and Sustainability
New Articles Discussed
Current news
Activities
- Video segment about depleted uranium called “Poison Dust”
- Group activity: Cross Bar Ranch’s Clear Lake group activity

Week 11
Current Topics
Appendix C: Environmental Science Inventory

ENVIRONMENTAL SCIENCE CLASS INVENTORY

Gender     Male □    Female □

Age range  18 to 25 □  26 to 42 □  43 to 60 □

Years since had a science course  0 to 5 years □  6 to 10 years □  11 to 20 years □  20+ years □

What is your major area of study? _________________________

Did you vote in 2004? Yes □ No □

Do you plan to vote in 2006? Yes □ No □

Think back to before you enrolled in your Environmental Science class

1. Did you think the class would be difficult? □ Yes □ No □ Maybe

2. Did you know that environmental science was political? □ Yes □ No

3. Did you know that environmental science had controversial issues? □
   Yes □ No

   If, yes.....name an issue you were aware of ____________________________

4. What was your level of interest in the environment?
   □ Didn’t care □ Somewhat cared □ Cared a lot

5. Did you read about the environment or watch television programs?
   □ Yes □ No
Appendix C (Continued)

Now that you have taken the Environmental Science Class

6. Name a fact that you learned in class that surprised you?

________________________________________________________________________

7. Have you shared your classroom experience with friends and/or family members?

   Yes □ No □ With whom?______________

8. Did you find any of the discussions in class to be uncomfortable or unsettling?

   If yes.....what aspect affected you?

________________________________________________________________________

Not at all Neutral Very uncomfortable

1  2  3  4  5

9. How has learning about environmental science influenced your way of thinking?

________________________________________________________________________

11. What level of interest do you have in being more active in the environmental movement?

   □ No interest □ Some interest □ Very interested

12. Have your behavioral habits changed since taking the class?

   □ Yes □ No □ Maybe

   If yes, name a few examples ____________________________

17. Which specific activities performed in class did you enjoy?

   Enjoyed the most ____________________________
   ____________________________
   ____________________________

   Enjoyed the least ____________________________
Appendix C (Continued)

18. Rank your teaching method preferences? (Power points (PP), writing on the board, discussion, combo of P.P. & discussion, combo of PP and writing on the board, combo of writing on the board and discussion)

   Enjoyed the most
   ____________________________
   ____________________________
   ____________________________

   Enjoyed the least
   ____________________________

19. To what extent did you like writing the “Reaction Papers”?

   Explain:

   Any other comments about anything you learned or your classroom experience:
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
Appendix D: Doctoral Colleague Attestation

I, Cyndy Leard, have served as a peer reviewer for "A Descriptive Study of Students’ Perspectives to Controversial Issues Embedded in a College Environmental Science Course" by Chyriss P. Tabone. In this role, I have worked with the researcher throughout the study in capacities such as reviewing notes and assisting in emerging issues.

Signed: [Signature]

Date: September 29, 2020
Appendix E: IRB Review Letter and Adult Informed Consent Form

Social Sciences/Behavioral
Adult Informed Consent
University of South Florida

Information for People Who Take Part in Research Studies
The following information is being presented to help you decide whether or not you want to be a part of a minimal risk research study. Please read carefully. If you do not understand anything, ask the Person in Charge of the Study.

Title of Study: A Descriptive Study of College Students’ Perspectives on an Environmental Science Course Embedded with Controversial Issues

Principal Investigator: Chyrisse P. Tabone
Study Location(s): University of South Florida, College of Education

You are being asked to participate in this study because you are a non-science major enrolled in an undergraduate environmental science course.

General Information about the Research Study
The purpose of this research study is to describe students’ perceptions of embedding controversial science issues in an undergraduate science course for non-science majors.

Plan of Study
- You will be asked to complete an environmental science inventory and participate in writing exercises. The study will require approximately 15 minutes of your time each week for 12 weeks.

Payment for Participation
- You will not be paid for your participation.

Benefits of Being a Part of this Research Study
- Your participation in the study may assist in improving science education reform which may benefit you and the public directly.

Risks of Being a Part of this Research Study
- There is no known risk to-participating

Confidentiality of Your Records
- Your privacy and research records will be kept confidential to the extent of the law. Authorized research personnel, employees of the USF Institutional Review Board, employees of the USF College of Secondary Education, and employees of the Department of Health and Human Services may inspect the records from this research project.

The results of this study may be published. However, the data obtained from you will be combined with data from other people in the publication. The published results will not include your name or any other information that would in any way personally identify you.

Each consent form will have a number which will correspond to the survey. If necessary, follow up may occur. The finished tabulated data will be kept at the College of Education.

IRB#
Appendix E (Continued)

Volunteering to Be Part of this Research Study

- Your decision to participate in this research study is completely voluntary. If you choose not to participate, or if you withdraw, there will be no penalty and no impact on student status or grades.

Questions and Contacts

- If you have any questions about this research study or suffer study-related harm, contact Chyrissa P. Tabone (Principal Investigator) at (813) 963-0196 or via email CHYRISSE@aol.com.

- If you have questions about your rights as a person who is taking part in a research study, you may contact a member of the Division of Research Integrity and Compliance of the University of South Florida at 813-974-8553.

Your Consent—By signing this form I agree that:

- I have fully read or have had read and explained to me this informed consent form describing a research project.
- I have had the opportunity to question one of the persons in charge of this research and have received satisfactory answers.
- I understand that I am being asked to participate in research. I understand the risks and benefits, and I freely give my consent to participate in the research project outlined in this form, under the conditions indicated in it.
- I have been given a signed copy of this informed consent form, which is mine to keep.

________________________________________  ____________________________________________  __________
Signature of Participant                  Printed Name of Participant                  Date

Investigator Statement

I certify that participants have been provided with an informed consent form that has been approved by the University of South Florida’s Institutional Review Board. That contains the nature, demands, risks and benefits involved in participating in this study. I further certify that a phone number has been provided in the event of additional questions.

________________________________________  ____________________________________________  __________
Signature of Investigator                  Printed Name of Investigator                  Date
Or Authorized research investigators
designated by the Principal Investigator

Institutional Approval of Study and Informed Consent

This research project/study and informed consent form were reviewed and approved by the University of South Florida Institutional Review Board for the protection of human subjects. This approval is valid until the date provided below. The board may be contacted at (813) 974-5638.

Approval Consent Form Expiration Date:

Revision Date: ________________

IRB#
Table 1. Demographic Snapshot of Students

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
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<tr>
<td><strong>Gender</strong></td>
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<tr>
<td>Female</td>
<td>52</td>
<td>78.8</td>
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<tr>
<td>Male</td>
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<td>21.2</td>
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<tr>
<td><strong>Age range</strong></td>
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<td></td>
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<tr>
<td>18 to 25 years (Millennial)</td>
<td>23</td>
<td>34.8</td>
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<tr>
<td>26 to 42 years (Gen X)</td>
<td>34</td>
<td>51.5</td>
</tr>
<tr>
<td>42 to 60 years (Baby Boomer)</td>
<td>9</td>
<td>13.6</td>
</tr>
<tr>
<td><strong>Years since last science course</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 to 5 years</td>
<td>23</td>
<td>34.8</td>
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<tr>
<td>6 to 10 years</td>
<td>16</td>
<td>24.2</td>
</tr>
<tr>
<td>11 to 20 years</td>
<td>20</td>
<td>30.3</td>
</tr>
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<td>20+ years</td>
<td>7</td>
<td>10.6</td>
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<tr>
<td><strong>Major</strong></td>
<td></td>
<td></td>
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<tr>
<td>Undecided</td>
<td>1</td>
<td>1.5</td>
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<tr>
<td>Medical</td>
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<td>34.8</td>
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<td>Paralegal</td>
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<td>Criminal Justice</td>
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<td>Business/Marketing</td>
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<td>12.1</td>
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<tr>
<td>Accounting</td>
<td>7</td>
<td>10.6</td>
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<td>Computers</td>
<td>4</td>
<td>6.1</td>
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<tr>
<td>English</td>
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Table 2. Voting Record and Future Voting Intentions

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<tr>
<th></th>
<th>Vote 2004 YES (Percent)</th>
<th>Vote 2004 NO (Percent)</th>
<th>Vote 2006 YES (Percent)</th>
<th>Vote 2006 NO (Percent)</th>
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<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Millennials</td>
<td>27.5</td>
<td>46.2</td>
<td>32.6</td>
<td>40</td>
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<tr>
<td>Gen X’ers</td>
<td>62.5</td>
<td>34.6</td>
<td>58.6</td>
<td>35</td>
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<tr>
<td>Baby Boomers</td>
<td>10</td>
<td>19.2</td>
<td>8.8</td>
<td>25</td>
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<tr>
<td><strong>Overall</strong></td>
<td>60.6</td>
<td>39.4</td>
<td>69.7</td>
<td>30.3</td>
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Table 3. Prior Perception of Environmental Science Course

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<tr>
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<th>Frequency</th>
<th>Percent</th>
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<tr>
<td><strong>Believed the class would be difficult</strong></td>
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<td>Yes</td>
<td>21</td>
<td>31.8</td>
</tr>
<tr>
<td>No</td>
<td>24</td>
<td>36.4</td>
</tr>
<tr>
<td>Maybe</td>
<td>21</td>
<td>31.8</td>
</tr>
<tr>
<td><strong>Knew environmental science is political</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>28</td>
<td>42.4</td>
</tr>
<tr>
<td>No</td>
<td>38</td>
<td>57.6</td>
</tr>
<tr>
<td><strong>Knew environmental science has controversial issues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>40</td>
<td>60.6</td>
</tr>
<tr>
<td>No</td>
<td>26</td>
<td>39.4</td>
</tr>
<tr>
<td><strong>Level of interest in the environment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not care</td>
<td>6</td>
<td>9.1</td>
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<tr>
<td>Somewhat cared</td>
<td>33</td>
<td>50.0</td>
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<tr>
<td>Cared a lot</td>
<td>27</td>
<td>40.9</td>
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<tr>
<td><strong>Watched environmental shows on television</strong></td>
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<td></td>
</tr>
<tr>
<td>Yes</td>
<td>45</td>
<td>68.2</td>
</tr>
<tr>
<td>No</td>
<td>21</td>
<td>31.8</td>
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Table 4. Interest, Sharing, and Behavior at Eleven Weeks

<table>
<thead>
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<th>Frequency</th>
<th>Percent</th>
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<tr>
<td><strong>Shared classroom experience with friends/family</strong></td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>60</td>
<td>90.9</td>
</tr>
<tr>
<td>No</td>
<td>6</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>Level of discomfort during discussions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No answer</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Very comfortable</td>
<td>13</td>
<td>19.7</td>
</tr>
<tr>
<td>Comfortable</td>
<td>6</td>
<td>9.1</td>
</tr>
<tr>
<td>Neutral</td>
<td>19</td>
<td>28.8</td>
</tr>
<tr>
<td>Somewhat uncomfortable</td>
<td>9</td>
<td>13.6</td>
</tr>
<tr>
<td>Very uncomfortable</td>
<td>18</td>
<td>27.3</td>
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<tr>
<td><strong>Level of interest in the environmental movement</strong></td>
<td></td>
<td></td>
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<tr>
<td>No interest</td>
<td>5</td>
<td>7.6</td>
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<tr>
<td>Some interest</td>
<td>31</td>
<td>47.0</td>
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<tr>
<td>Very interested</td>
<td>30</td>
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<tr>
<td><strong>Change in behavioral habits since taking course</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>43</td>
<td>65.2</td>
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<td>No</td>
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<td>12.1</td>
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<td>Maybe</td>
<td>15</td>
<td>22.7</td>
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Table 5. Teaching Method Preferences

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<td>Power Points</td>
<td>11</td>
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<tr>
<td>Writing on board</td>
<td>4</td>
<td>6.1</td>
</tr>
<tr>
<td>Power Points &amp; discussion</td>
<td>17</td>
<td>25.8</td>
</tr>
<tr>
<td>Discussion</td>
<td>16</td>
<td>24.2</td>
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<tr>
<td>Power Points &amp; board writing</td>
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<td>7.6</td>
</tr>
<tr>
<td>Board writing and discussion</td>
<td>10</td>
<td>15.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preferred classroom activity</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinkhole demonstration</td>
<td>19</td>
<td>28.8</td>
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<tr>
<td>Sinkhole &amp; discussions</td>
<td>4</td>
<td>6.1</td>
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<td>Plastics recycling activity</td>
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<tr>
<td>Discussion</td>
<td>15</td>
<td>22.7</td>
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<tr>
<td>Field trip</td>
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<td>9.1</td>
</tr>
<tr>
<td>Field trip &amp; research paper</td>
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<td>1.5</td>
</tr>
<tr>
<td>Group activities</td>
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<td>7.6</td>
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<tr>
<td>Reaction papers</td>
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Appendix F (Continued)

Figure 5. Gender

Figure 6. Age range
Appendix F (Continued)

Figure 7. Years since studying science

Figure 8. Majors of study
Figure 9. Voted in 2004 election

Figure 10. Intend to vote in 2006 mid-term election
Appendix F (Continued)

Figure 11. Students who knew environmental science is political

Figure 12. Students who knew environmental science has controversial issues
Figure 13. *Prior to enrollment*—Level of interest in the environment

Figure 14. *After eleven weeks*—Level of interest in environmental movement
Figure 15. *Prior to enrollment*—Reading and watching TV shows about the environment

Figure 16. Sharing classroom experience with friends and/or family
Appendix F (Continued)

**discomfort**

Figure 17. Level of comfort felt during class discussions

**behavior**

Figure 18. Have your behavioral habits changed since taking the course?
Figure 19. Student preferred teaching methods
About the Author

Chyrisse P. Tabone received a Bachelor’s Degree in Environmental Science from Florida Institute of Technology in 1983, a Master’s of Science Degree in Science Education (Chemistry Option) from Florida International University in 1991, and a Master’s of Science in Public Health Degree in Toxicology from University of South Florida in 2002. She has worked professionally as an environmental scientist for over 20 years, specializing in petroleum contamination and hazardous waste.

Ms. Tabone entered the Ph.D. program in Curriculum and Instruction (Science Education) at the University of South Florida in 2002. She has instructed college level environmental courses for approximately two years. Ms. Tabone has also coauthored an article in Science Teacher, performed several paper presentations at various science education associations, and developed curriculum for a local environmental science center.