assessing cognitive processes, instructor strategies, and the transdisciplinary nature of course offerings in post-secondary sustainability education programs

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Assessing cognitive processes, instructor strategies, and the transdisciplinary nature of course offerings in post-secondary sustainability education programs

by

Dennis L. Wilson

A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Family and Consumer Sciences Education

Program of Study Committee:
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Nancy Grudens-Schuck
Young-A Lee
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Mack Shelley

Iowa State University
Ames, Iowa

2012

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DEDICATION

Dedicated to Laurie in gratitude of her love, support, and patience throughout this endeavor and to my children, Jennifer, Katlin, and Mara and granddaughter Kamryn.

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ABSTRACT

The purpose of this case study was to describe, assess, and compare the cognitive level of instruction, course objectives, instructional strategies, assessments, and the transdisciplinary nature of two post-secondary degree programs in sustainability. Instructional strategies in these programs included such methods as class presentations, group activities, and interaction with students. The populations for the case studies consisted of instructors and administrators from two undergraduate courses at the Arizona State University School of Sustainability and two graduate courses at Portland State University Institute for Sustainable Solutions. The cognitive levels of instruction were derived from courses selected from the core curriculum at each university and measured using the Florida Taxonomy of Cognitive Behavior (FTCB) model based on Bloom’s Taxonomy. The instructors' discourse, in-class activities, and interactions were evaluated in reference to their cognitive level of instruction. Student assessment methods and course objectives from the syllabi were also evaluated to assess the intended levels of cognitive instruction. The evaluation of instruction was conducted through direct observation of four courses at each university, with multiple observations during the fall 2011 and spring 2012 semesters. This research also examined the transdisciplinary nature of sustainability courses offered in each university program obtained from class syllabi, course catalogs, and university websites.

Findings from the research showed transdisciplinary studies were offered and required in the curriculum for both the ASU programs and the PSU programs that were examined. The core courses in sustainability were balanced in regard to required courses in the economics, environmental, and societal domains, however elective courses at both institutions tended toward environmental sciences more heavily.
Higher order cognitive instruction was evident in an average of 50% of the instructor discourse for the four classes studied. The average time spent at each level revealed application at 17%, analysis at 17%, synthesis at 12%, and evaluation at 4%. The weighted average cognitive levels ranged from a low of 25 to a high of 30 indicating discourse between the comprehension level and the application level. A comparison study showed no significant difference in instructor discourse between sustainability instructors and a 2005 study evaluating pre-service teachers.
CHAPTER 1 – INTRODUCTION

Educating the public is an essential component of balancing Earth’s scarce and finite resources with the demands of human consumption and waste (Agardy & Nemerow, 2005; UNESCO, 1998). Moore (2005a) and others in the field of education (Jones, Selby & Sterling, 2010; Warburton, 2003; Weinberg & Harding, 2004) see sustainability education as the responsibility of post-secondary institutions with the capabilities and resources to offer these programs. As Moore (2005a) states, “Given what academics know about the current ecological condition of the planet, there is an obligation for universities to become leaders in the movement to prevent global ecological collapse” (p. 326). However, with the rapid influx of courses and degrees in the expanding pedagogy of sustainability, there is a call for a reorientation or transformation of the traditional pedagogy to focus on transdisciplinary studies and higher order levels of cognitive learning. This research study will examine the current state of sustainability programs at two universities in regard to transdisciplinary content, higher order levels of instruction, and the alignment of instructor strategies.

Sustainability is not a new concept. To the contrary, Gibson (2005) terms it an “old wisdom, perhaps the old wisdom” (p. 39), citing its many titles and culturally rooted history since the dawn of recorded civilization. However, with the advent of the industrial age and its focus on productivity, competition, and economic efficiency, this wisdom has been slowly eroded and replaced by mass consumption and neglect (Carson, 1962; Roseland, 2005). It is generally agreed that changes to these practices are not minor adjustments to existing processes. Instead, they require a major change in attitudes and, most importantly, a knowledgeable and educated public (Cotton & Winter, 2010; Hallsmith, 2003; Roseland, 2005). Simply stated, sustainability education is central to our long-term survival.
Building Sustainability Pedagogy

There is a considerable body of literature that advocates placing the responsibility for sustainability education on post-secondary institutions (Steinfeld & Mino, 2009; Talloires Declaration, 2011; Jennings, 2011. In, Peter Blaze Corcoran, Director of the Center for Environmental Studies and Environmental Education of Florida Gulf Coast University, describes higher education’s “moral responsibility to respond” to sustainability (Jones et al., 2010, p. xiv) and to review its history in respect to interdisciplinarity, international perspectives, and pedagogy. However, to meet this responsibility, there is a need to adapt and reorient traditional education toward a focus that is reflected in two recurring themes:

- Higher education programs must incorporate transdisciplinary or interdisciplinary studies (See Definition of Terms in Chapter 1 for clarification of terms).
- Instructional strategies must engage students in higher order levels of cognitive learning.

As Burns (2011) notes, “Since sustainability is rooted in deep ethical and spiritual commitments (Hawken, 2007), postsecondary educators need to find ways to not only teach sustainability, but to do so in a way that acknowledges the personal and collective transformation inherent in sustainability work” (p. 2). According to Burns, the elements inherent in this transformation include interdisciplinary studies, critical thinking, active learning, and an understanding of the interaction of community and environment.

Transdisciplinary Studies

Integrating transdisciplinary studies or a holistic concept of sustainability is a substantive element of a comprehensive education, particularly in creating formative higher
education programs (Dale & Newman, 2005). Dale and Newman see the goal of sustainable development education as an opportunity for students “to explore the reconciliation of critical ecological, social, and economic imperatives” (p. 354).

The logic behind implementing a comprehensive or transdisciplinary program of study is that complex systems are interrelated. The economic, social, and environmental domains of sustainability share a common space: changes in one domain, no matter how subtle, may directly affect others. As Hallsmith (2003) concluded, complex systems such as the link that connects humankind and our planet’s ecosystem require holistic knowledge across multiple disciplines. According to the author, solutions to problems in a complex system may become problems themselves if thought is not given to the consequences and ramifications of these actions. She states, “…as long as we cling to the problem solving model, we will never run out of problems and the need for solutions” (p. 83).

In The Key to Sustainable Cities, Hallsmith supports a holistic or “systems thinking” approach to address the issues associated with creating sustainable development: “Isolated problem solving has been the dominant practice for public policy and even for some sustainable development methodologies” (p. 84). The shortcoming inherent in an isolated approach is that a lack of knowledge in one field or area of expertise may result in unforeseen impacts, creating a situation worse than that which originally existed. For sustainable development, this means that social, environmental, and economic educational needs “must be met in balance with each other for sustainable outcomes [to occur] in the long term” (UNCED, 1992, para. 5).

Sustainable development is generally represented by a series of overlapping concentric circles representing the economic, social, and environmental domains of
sustainability (Gibson, 2005; Harris, 2000). Mebratu (1998) illustrates this same concept with a structural analogy of three pillars mutually supporting sustainability through the integration of economic, social, and environmental policies. In both cases, the metaphors are intended to show the integration of the concepts and the common ground shared by the interaction of “human activities in the identified sectors” (Gibson, 2005, p. 58).

The dual premise behind transforming higher education is to support the conceptual framework of sustainable development with transdisciplinarity and higher order learning skills, and to create “a space for pedagogical transformation” (Moore, 2005a, p. 331). In the engineering vernacular, the reorientation of traditional education to sustainability education requires the support of two pillars: higher order cognitive levels or critical thinking skills and a holistic approach to teaching across the three domains of sustainability (see Figure 1.1).

![Figure 1: The support pillars of sustainability education](image)

**Higher Orders of Cognitive Learning**

Sterling (2004) sees the need for transdisciplinary course offerings as important, but notes that the integration of sustainability into higher education will also require a shift from
a low level of cognitive learning to a high level of cognitive learning. Springett (2010) also advocates an approach to sustainability education that connects transdisciplinary studies with higher order learning skills. He contends that sustainability education must be holistic, and transdisciplinary. In addition, Springett supports pedagogical choices that engage both teachers and students in “action research” and other methods that provide “experiential learning and help to create democratic learning contexts” (p. 76).

Newman (1990) sees the development of these higher order thinking skills as a crucial element in providing responsible, empowered, and productive citizens. Ball and Garton (2005) described it as an “aim of education for the 21st century” and as “a goal for educational institutions” (p. 58). Dale and Newman (2005) also see this skill set as a critical tool of instruction: “Sustainable development literacy must focus on the teaching of thought processes capable of understanding and developing novel responses to dynamically evolving and changing situations” (p. 356).

For relatively new areas of study such as sustainability education, this is a difficult process, especially in light of the rapid expansion and diversification of the field. Studies indicate that the sphere of sustainability education often focuses on definitions that are either too vague, expanding the term to include everything (Disinger & Roth, 1992) or too focused on a particular domain within the student’s major field of study (Davis, 2001). For universities and educators, responding to this challenge means creating programs of study that are general enough to cover the scope of sustainability, but narrow enough to encourage higher order learning outcomes.

It should be noted that lower order cognitive processes are not the antithesis of higher order instruction and as with transdisciplinary studies; they are an integral part of the process
itself. The complexity of educating across disciplinary boundaries creates a mutual reliance upon the lower and higher order levels of cognitive thought processes. Students as well as academics develop a natural affinity toward specific fields of study and subsequently gain significant knowledge and expertise within these areas. The implication of requiring a broader span of proficiency within each of the domains of sustainability is that lower order skills must first be mastered before aptitude can be developed in the higher order processes.

**Opportunities for Higher Education**

The solution to providing higher level cognitive learning and creating a transdisciplinary curriculum must come from within the university system. Cotton and Winter (2010), among others (Moore; 2005a; Tsui, 2002), see curriculum and program development as critical in creating an interdisciplinary post-secondary sustainability education program that can teach higher order learning skills to students in certificate and degree programs. The resolution of sustainability problems can encompass a variety of disciplinary learning, such as environmental, chemical, and biological knowledge, and a variety of fields, including engineering, geotechnical, and biology (Chalkey, Blumhof, & Ragnarsdottir, 2010). Thus, the pedagogy for sustainability education must incorporate diverse academic disciplines into its curriculum and must feature courses that can enhance and encourage critical thinking skills.

**Bloom’s Taxonomy of Educational Objectives**

Bloom’s taxonomy provides a metric for measuring knowledge or, more specifically, measuring cognitive skills in learning and instruction (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956). It has been used to study epistemological theories in a number of studies (Whittington & Newcomb, 1993; Ulmer & Torres, 2007). In this framework, Bloom’s
taxonomy has the ability to create a more definitive measure of knowledge and subsequently to identify the educational strengths or deficiencies in instruction.

*Bloom’s Taxonomy of Educational Objectives* (Bloom et al., 1956) identified three learning domains: cognitive, affective, and psychomotor. Cognitive domain skills are those involving knowledge and intellect; the affective domain deals with emotional learning including feelings, values, and motivation; and the psychomotor domain consists of physical skill development. The only metric from Bloom’s taxonomy used in this study was the cognitive domain, which is commonly explored in post-secondary institutions and includes six levels or stages as shown in Table 1.

**Table 1 Bloom's Taxonomy**

<table>
<thead>
<tr>
<th>Level Description</th>
<th>Level Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>1</td>
</tr>
<tr>
<td>Comprehension</td>
<td>2</td>
</tr>
<tr>
<td>Application</td>
<td>3</td>
</tr>
<tr>
<td>Analysis</td>
<td>4</td>
</tr>
<tr>
<td>Synthesis</td>
<td>5</td>
</tr>
<tr>
<td>Evaluation</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: Adapted from Bloom et al., 1956.

Knowledge and Comprehension are considered lower order levels of learning, in Bloom’s Taxonomy, while Application, Analysis, Synthesis, and Evaluation are categorized as higher order levels of learning. The probability of occurrence for lower order levels is higher in the classroom due to the simple and commonplace nature of these educational objectives (Newcomb & Trefz, 1987). Knowledge is described as the ability to recognize or
recall information and can include such tasks as recognition or recall (Center for Excellence, 2011). For instructors, these objectives can be stimulated by asking students to read, list, label, or describe. Comprehension demonstrates that the student can understand and organize thoughts and concepts. Key words for stimulating this level of cognitive ability include interpret, order, group, and translate.

The higher order levels of learning are more complex and occur less frequently (Newcomb & Trefz, 1987). Application refers to applying knowledge gained previously to reach an answer (Center for Excellence, 2011). This higher level is activated through words such as apply, demonstrate, classify, and calculate. Analysis is the fourth level of Bloom’s taxonomy and requires students to think critically or reflectively. Key words for developing this thought process include analyze, connect, differentiate, and infer. Synthesis is the process of applying prior knowledge or synergizing different elements to create a new whole. Words associated with this level of higher order thinking include adapt, collaborate, devise or formulate. The highest level in Bloom’s hierarchy is evaluation. This involves judging the value using one’s own opinion based on knowledge gained through the other five levels. Words that stimulate this process include appraise, compare and contrast, evaluate, and reframe.

A variation on Bloom’s work is the Florida Taxonomy of Cognitive Behavior (FTCB) (Webb, 1970). Based on Bloom’s original taxonomy, the FTCB is used as an assessment tool for analyzing levels of learning in the classroom. The process employs levels that mirror Bloom’s, with the exception of splitting the Comprehension level into the two distinct categories of Translation and Interpretation. The FTCB was developed to measure the frequency of occurrences when instruction is taught at a specific cognitive level. The FTCB
score sheet is divided into ten six-minute observation periods and administered by a rater who observes the instructor’s discourse and methods. The point of the measurement system is to determine the approximate percentage of time spent instructing at each of the six cognitive levels during a one-hour class. In typical cases, the research sample consists of multiple observations for each course that is evaluated.

**Purpose of the Study**

The purpose of this study was to describe, assess, and compare the cognitive level of instruction, course objectives, instructional strategies, assessments, and the transdisciplinary nature of two post-secondary sustainability education programs. The pedagogy employed during class included presentations, group activities, and interaction with students. The design of this study was a descriptive-correlational multi-case research study (Creswell, 2008). The qualitative data were collected as an embedded case study. Embedded case studies “apply multiple methods for data generation” (Scholz & Tietje, 2002, p. 3), which in this case included interviews and class observations.

**Research Objectives**

The following research objectives were used to address the problem and guide the research study:

1. Describe the demographic characteristics related to each instructor’s years of teaching experience and position(s) held at the university.
2. Describe the transdisciplinary nature of the curriculum in sustainability degree and certificate programs related to the social, economic, and environmental domains of sustainability.

4. Determine the difference between sustainability instructors’ percentage of time spent at each cognitive level through instructor discourse and agricultural and pre-service teachers’ percentage of time at each cognitive level as measured in previous studies.
   a. $H_0$: There is no difference between sustainability instructors’ percentage of time spent at each cognitive level and agricultural and pre-service instructors’ percentage of time spent at each level.

5. Describe the characteristics of the sustainability classes (number of students, student to teacher ratios, instructional plans, gender diversity, and interactions between students and the instructor).

6. Describe the instructional strategies employed to achieve higher order levels of learning in class.

7. Determine the cognitive level of course objectives and assessments and compare them to the cognitive levels of instructor discourse.

**Need for the Study**

Higher education faces the challenge of building a pedagogy for sustainability programs that not only focuses on sustainability education, but also is itself sustainable. Sterling (2004) summarizes this need as a reordering of higher education toward a more holistic approach, focused on higher order cognitive skills. The author supports the premise that changes in “provision and practice” (p. 49) are important, but represent only one aspect of educational change. He emphasizes that attention must also be given to the beliefs and ideals of sustainability, the purpose behind this education, and policies within the institutions.
of higher education. The ethos of sustainability education must also be addressed at the classroom level through cohesive and aligned instructional strategies.

The proliferation of universities offering certificates, minors, majors, and degree programs in sustainability has created a need to evaluate the current status of education in these post-secondary institutions. Transdisciplinary learning and the development of coursework and instruction to develop higher order learning skills is seen as critical in building our understanding of sustainability (Warburton, 2003; Filho, 2000; Dale & Newman, 2005). As noted by Warburton:

Because of the range and interconnectedness of environmental, social and economic issues, and the importance of interdisciplinary thinking and holistic insight, deep learning is particularly relevant in the context of education for sustainability (2003, p. 44).

These evaluation data have the potential to benefit administrators in developing their course offerings and curriculum. Professors can benefit from improved educational practices, and the students benefit through the delivery of these services.

Analyzing Higher Orders of Cognitive Learning

In order to analyze the sustainability programs’ levels of instruction and determine whether improvement was warranted, the research process involved classroom observations of instructor strategies, research on the curricula, and interviews with administrators and professors. As previously noted, the measurement of cognitive learning levels was conducted using the Florida Taxonomy of Cognitive Behavior (FTCB) (Webb, 1970). This metric provided data on classroom discourse in the form of percentage of time spent at each of the seven cognitive levels of learning (Webb, 1970). The importance of determining
higher order learning skills for this research is evident, because analyzing and resolving problems in complex systems such as sustainable development are “fundamental to the disciplines and bedrock of professional practice” (Flint, 2010, p. 213).

Instructional strategies also included course objectives and assessments. The course objectives and assessments were drawn from copies of the various course syllabi. The cognitive levels of both the objectives and the assessments were derived using key words and phrases from Bloom’s taxonomy and the FTCB (Webb, 1970). Assessments were also evaluated based on studies by Tsui (1999) and Astin (1993). According to studies by these researchers, growth in critical thinking was negatively correlated with multiple choice exams and positively correlated with:

- Independent research projects
- Group projects
- Class presentations
- Essay exams
- Having a paper critiqued by the instructor
- Positive interaction with the instructor

**Definition of Terms**

Sustainability is defined by its ambiguity. However, the terms that describe the nature of the environmental, economic, and social domains require a more definitive structure, especially in regard to epistemology. The following definitions are intended to clarify the terminology used in this research study.

*Assessment:* A general term that includes the full range of procedures used to gain information about student learning (observations, ratings of performances or projects, paper-
and-pencil tests) and the formation of value judgments concerning learning progress (Linn, Miller, & Gronlund, 2005).

*Bloom’s Taxonomy of Educational Objectives/Bloom’s Taxonomy:* A framework for categorizing educational objectives in one of three domains: Cognitive, Affective, and Psychomotor skills (Anderson et al., 2001). For purposes of this study, the cognitive level was the sole domain of reference and consists of Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

*Cognitive Category or Domain:* The category or domain focused on the intellectual component of the communication (Simon & Boyer, 1974).

*Critical Thinking:* An attitude in which a person searches for ideas, manipulates previous knowledge, and applies experiences (Von Oech, 1990).

*Deep Learning:* Deep learning is associated with the use of analytical skills, cross-referencing, imaginative reconstruction, and independent thinking (Warburton, 2003).

*Discipline:* A way of ordering knowledge for teaching and learning (Jones et al., 2010).

*Florida Taxonomy of Cognitive Behavior:* An observational system based on Bloom’s Taxonomy designed to measure the cognitive behavior of both students and teachers in a classroom (Webb, 1970).

*Higher Order Thinking:* The upper four levels of Bloom’s Taxonomy (Bloom et al., 1956), including Application, Analysis, Synthesis, and Evaluation. A cognitive process that occurs when a student “takes new information and information stored in memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations” (Ball & Washburn, 2001).
**Interdisciplinary Studies:** A process of answering a question, solving a problem, or addressing a problem that is too broad or complex to be dealt with adequately by a single discipline or profession (Klein, 1990). Often used interchangeably with transdisciplinary.

**Levels of Cognition:** The six levels (Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation) of Bloom’s Taxonomy (Bloom et al., 1956) utilized to classify cognitive processes elicited by questioning strategies and/or verbal behavior (Ball & Washburn, 2001).

**Multidisciplinary Studies:** Embedding (sustainability) courses within other disciplines of study (Cook, Cutting, & Summers, 2010).

**Transdisciplinary Studies:** Where courses or research questions cross disciplines and theories and concepts are tested across disciplines (Jones et al., 2010). Often used interchangeably with interdisciplinary.

**Conceptual Framework**

The conceptual framework for this research study examined sustainability education from the perspective of a cohesive field of discourses or domains (economics, social change, and environmental sustainability) layered within a cognitive learning process. The goal of post-secondary institutions of higher education should be to provide a comprehensive understanding of these domains within the field of study, while extending knowledge progressively deeper with each course. This descriptive-correlational multi-case research study analyzed two colleges with majors in sustainability to determine whether the educational programs are meeting this goal.

**Research Questions**

The research questions that this study will address are:
1. What instructor strategies are employed that encourage higher order learning skills in sustainability education classes in post-secondary sustainability degree programs?

2. What percentage of an instructor’s time is spent at each of the cognitive levels of learning within the selected classes?

3. Is there significant variance between the cognitive levels of teaching within the selected classes?

4. Is there significant variance between the cognitive levels of instruction between sustainability classes and agricultural courses?

5. Are the curricula in sustainability degree programs transdisciplinary, addressing the range of domains that comprise sustainability?

6. How do the transdisciplinary course offerings of the two universities in the study rank against the course offerings of other post-secondary sustainability degree programs?

**Assumptions**

For the purposes of this study the following were assumed:

1. Bloom’s Taxonomy is a valid instrument for categorizing and analyzing cognitive levels of instruction.

2. The validity of the Florida Taxonomy of Cognitive Behavior is based on Bloom’s Taxonomy and therefore is a valid framework for categorizing cognitive levels of instruction.

**Limitations of the Study**

The findings for this study are limited to the two schools that participated in the study. Any comparisons or generalizations to other institutions should only be drawn within the context of the participating universities. An additional limitation is that the samples of
participants from each university were purposefully selected based on availability of the professors and students as well as the permission from the administration of each college. Therefore, the sample is not representative of the population.

Maxwell (2005) indicated that an observer’s presence in class may change the typical classroom behavior of the subjects. In addition, the qualitative analysis performed as part of this study included bias from the researcher’s “theories, beliefs, and perceptual lens” (p. 108), which cannot be eliminated.

Only agricultural education instructors were compared to sustainability educators for the correlation study on higher level cognitive instruction. No other departments or programs were analyzed as part of this research. In addition, the sample size used for the agricultural education instructors was small and therefore not representative of the population of agricultural education instructors.

The post-secondary schools selected for this study were drawn from a list of 23 universities with graduate degree programs and 8 certificate programs focused on sustainability (Masters, n.d.; Certificates, n.d.). Although permission was sought from other university programs which were examined (Calder, 2005; Stars Institutions, 2011), Arizona State University’s School of Sustainability in Tempe and Portland State University’s Institute for Sustainable Solutions were purposefully selected to participate based on their national reputation and broad-based educational theme in sustainability. Additional information on the universities within the sample frame is included in Appendix A.

Relevancy to Major

Family and Consumer Sciences Education (FCSE) is a diverse field of study with a variety of concentrations. As noted by Brown and Paolucci (1993), “The knowledge
appropriate to home economics [FCSE] is drawn from a number of disciplines, uniquely selected, organized, and transformed for practical use” (p. 10). During much of the 20th century, traditional home economics focused on the content areas of textiles, clothing, housing, interior design, home management, consumer studies, foods, nutrition, child development, and family relations (Richards, 2000). However, a landmark change in the direction of FCSE took place in 1979 with *Home Economics, A Definition* by Brown and Paolucci (1993), which was later published by the Home Economics Association. This document sought to better define the field as both a profession and “a practical science concerned with the home and family” (p. v) and was a significant factor in prompting home economists to debate the feasibility of changing the name to more accurately meet this shift in focus. The end result of this discussion led to a meeting entitled *Positioning for the 21st Century* in Scottsdale, Arizona in October 1993 and ultimately led to a name change from home economics to Family and Consumer Sciences (Stage & Vicenti, 1997).

Family and Consumer Sciences (FACS) administrators, educators, and others gathered for a strategic planning session in Washington, DC during this same timeframe. According to the Indiana Department of Education website, “The definitions and directions defined at the conference in Scottsdale were aligned with the vision and mission statements developed for Family and Consumer Sciences Education, and the work was merged” (Botine, 2010, para. 4). The result of this union was the development of the 16 FACS areas of study shown in Table 2.
Table 2 Standards and Competencies for Family and Consumer Sciences

<table>
<thead>
<tr>
<th>Career, Community &amp; Family Connection</th>
<th>Facilities Management &amp; Maintenance Family</th>
<th>Food Science, Dietetics &amp; Nutrition</th>
<th>Interpersonal Relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer &amp; Family Resources</td>
<td>Family</td>
<td>Hospitality, Tourism &amp; Recreation</td>
<td>Nutrition &amp; Wellness</td>
</tr>
<tr>
<td>Consumer Services</td>
<td>Family &amp; Community Services</td>
<td>Housing, Interiors, &amp; Furnishing</td>
<td>Parenting</td>
</tr>
<tr>
<td>Education &amp; Early Childhood</td>
<td>Food Production &amp; Services</td>
<td>Human Development</td>
<td>Textiles, Fashions, &amp; Apparel</td>
</tr>
</tbody>
</table>

Source: Adapted from National Association of State Administrators for Family and Consumer Sciences [NASAFACS], 1998.

Of the 16 specialty areas, all but four of the comprehensive standards encompass sustainability in one or more of their competencies. These competencies lie within transdisciplinary areas including the environment (recycling; conservation of resources and energy; waste management), economics (consumer economics; government regulations; needs and wants of the individual), and social equity (impacts of social and cultural diversity; globalization of cultures; social, emotional, economic, vocational, educational, and recreational issues for individuals and family) (National Association of State Administrators for Family and Consumer Sciences, 1998). An example of the comprehensive standards pertaining to sustainability and competencies is included in Appendix B.

**Summary**

The reorientation of higher education is fundamental to the future of sustainability (UNESCO, 1998). This pedagogical transformation must include a program of study that crosses disciplinary boundaries and encourages critical thinking skills to create responsible,
empowered, and productive citizens (Newman, 1990). This responsibility necessitates a cooperative effort between administrators, instructors, and curriculum developers operating through interdisciplinary channels.

This mixed methods case study examined sustainability programs at the Arizona State University School of Sustainability and Portland State University Institute of Sustainable Solutions. The purpose of this study was to undertake a critical analysis of instructor discourse and instructor strategies relating to transdisciplinary studies and the levels of cognitive instruction. The chapters that follow include a literature review, methodology, findings, and conclusions in the context of the research topics and objectives of this study.
CHAPTER 2 – LITERATURE REVIEW

The value of recorded history lies in its ability to mark events of success and failure. This log of human endeavors is replete with costly lessons that are often expensive in terms of both environmental damage and loss of life (Carson, 1962). In 2003, Glasby concluded that “we live in a world where environmental degradation is pervasive and accelerating” (p. 336). Glasby’s solution called for a drastic reduction in both the world’s population size and resource use, which may or may not be attainable. But regardless of the solution, education is paramount to the success of any endeavor. As Cortese stated, “the change in mind-set necessary to achieve this vision is a sustained, long-term effort to transform education at all levels (2003, p. 16). This chapter assesses the literature relevant to sustainability education, including the responsibilities of secondary education, the reorientation of traditional education including transdisciplinary studies and, the need for higher order learning skills.

Responsibilities of Higher Education

Carson (1962) saw environmental devastation as a “victim of indifference” (p. 39), with dramatic effects resulting from apathy and ignorance. The earth is a system of complex interconnections of biotic and abiotic resources (Daly & Farley, 2004) and requires higher order thinking to maintain its equilibrium (Hagedorn et al., 1999).

International, industrial, and professional organizations, as well as governments and a wide range of academic committees, look to higher education institutions to create sustainable solutions to environmental, societal, and economic challenges (Stewart, 2010). A paper by UNESCO (1998) concluded that there is a profound need for educational systems to take on this challenge to meet the future needs of our society. This appeal literally and
pragmatically compels colleges and universities to accept this responsibility for developing sustainability education programs.

There is a history of organizational support for the precept that the foundation of sustainability education must come from post-secondary institutions of higher learning. The Brundtland Report (1987) was not the first concerted effort to seek recognition and resolution of environmental and social issues, but it fostered papers, reports, and conferences that raised awareness and, in many cases, plans of action for global change. One of these documents, Agenda 21, was passed in 1992 in Rio de Janeiro and emphasized the need for dramatic shifts in attitudes and practices of consumption, processes, and production (UNCED, 1993). One of the critical means of implementation that was considered “indispensable to changing people’s attitudes” was to “enhance formal and non-formal education programmes on environment and sustainable development at all levels for people of all ages” (UNCED, 1993, Section 36.3). Education was seen as critical to “promoting sustainable development and improving the capacity of the people to address environment and development issues” (UNCED, 1993, 36.3). The action proposed to complete this goal was to emphasize an approach toward interdisciplinary and integrative curricula in education programs, including those in universities (UNCED, 1993).

An international conference in Talloires, France in 1990 was the birthplace of the Talloires Declaration, a formal declaration by universities committing them to sustainability education (Talloires Declaration, 2001). The framework of this document contained a ten-point action plan (see Appendix C) signed by over 430 universities from 52 countries that encouraged cooperation in sustainability and environmental literacy within the fields of teaching, research, operations, and outreach at colleges and universities. Although both
primary and secondary educational institutions were included in the declaration, universities were tasked with accomplishing the central goals of education, research policy formation, and the exchange of information by incorporating interdisciplinary efforts in both curricula and campus initiatives.

**Transforming Sustainability Education**

**Sustainability domains**

A comprehensive understanding of the domains of sustainability is relevant to the reorientation or transformation of educational practices. This first step toward environmental literacy is critical to the creation of an informed public capable of understanding the concepts of sustainable development, the interconnected nature of our environment and culture, and the ability to adapt solutions as warranted in this dynamic system (Stracham, 2009).

However, examining the many specialized fields that have developed since the inception of sustainability demonstrates the magnitude in formulating a definition of the domains of sustainability and narrowing them to a “one-size-fits-all” model (Daly, 1996, p. 9).

The pedagogical effects of developing a more refined definition are perhaps most evident in our post-secondary educational systems. Abel & Stepp (2003) discussed these impacts in *A New Ecosystems Ecology for Anthropology*:

An explosion of ecological–environmental specializations is now spreading through academic departments, including historical ecology, environmental history, political ecology, eco-feminism, environmentalism, environmental justice, symbolic ecology, ethno-ecology, human ecology, evolutionary ecology, environmental anthropology, ecological anthropology, ecological economics, sustainable development, traditional
ecological knowledge (TEK), conservation, environmental risk, and liberation ecology (para. 3).

The extent to which environmental studies have become specialized can contribute to a holistic or transdisciplinary perspective in schools: however, the depth of the field of sustainability extends well beyond one discipline. The sustainability disciplines or domains that should be involved in this doctrine vary greatly and have been debated in a vast number of articles. As an example, Pezzoli (2006) included ten discourses within the sphere of sustainable development, while others (Rinzin, Vermeulen & Glasbergen, 2007) consider four pillars (economic, social, environmental and culture).

Brent and Labuschagne (2004) stated that sustainability and sustainable development had over 100 definitions, “but most agree that the concept aims to satisfy social, environmental and economic goals” (p. 2). These goals, also known as the three metaphorical pillars of sustainable development (Azapagic & Perdan, 2000; Gibson, 2005) are considered by many to be the commonplace objectives of the field (Sillanpaa, 1999; Global Responsibility, 2012). Although there may not be consensus on the number of applicable domains or sustainability, the economic, social, and environmental imperatives are well defined and accepted in most fields of study (Gibson, 2005; Goreham & Stofferahn, 2001; Mebratu, 1998). Three concentric or overlapping circles are also a common representation of this interconnected system. However, the analogy of the pillars is indicative of a non-redundant system of support where the forces bearing upon each of these three pillars must remain in stasis for sustainability to function (Villa & Mitchell, 2009).
Complex systems

Meeting the challenges of sustainability and its complex relationship with environmental, economic and social issues requires solutions that are conceived through interdisciplinary approaches and employ critical problem solving skills (Borrego & Newswander, 2010; NIH, 2006; NSF, 2006). This requires educators to challenge students to analyze, diagnose, and plan effective strategies, and to vacate the role of merely proffering knowledge (Knowles, 1970) as practiced in the role of traditional education.

According to Miller, Munoz-Erickson, and Redman (2011), the frameworks that higher education institutions use to guide these new education strategies generally lack applicability to sustainability program development. The authors define sustainability knowledge as knowledge that:

- Recognizes the complexity of system dynamics;
- Is socially robust;
- Is acknowledged by multiple epistemic cultures; and
- Incorporates normative criteria (p. 179).

Miller et al., (2011) contend that the elements of sustainability education can easily be taught within each disciplinary field of study in the classroom, but the complexity of the real world’s problems require more than a multidisciplinary approach. The diverse and dynamic nature of sustainability issues requires transdisciplinary coursework, systems thinking (Miller et al., 2011; Stracham, 2009), and an understanding of community and place (McKibben, 2007; Roseland, 2005; Hallsmith, 2003). Traditional instruction treats variables in isolation, neglecting the overall impact within the integrated systems (Miller et al., 2011). These practices produce knowledgeable individuals who are aware of the issues but who
have limited capacities to frame the problems and “adapt to changing societal conditions…to address the normative nature of sustainability issues” (Miller et al., 2011 p. 179).

Burns (2011) sees similar issues with the traditional pedagogy in institutions of higher learning. Although sustainability education focuses on the examination of and possible solutions to existing problems, it does not engage the students in the “how” of these complex issues. Sustainability education must be modeled in a manner than involves systems thinking, reflective learning, problem-based learning, and methods of learning that incorporate group work, community projects, and primary research (Moore, 2005a; Burns, 2011). The sustainability imperative for education must include an epistemology of “knowledge, values and skills to be able to contend with the pressing and complex ecological and social problems in the places where [students] live and work” (Burns, 2011, p. 2).

The transformation of higher education to meet the needs of sustainability must necessarily produce a cohesive program of study that offers students the opportunity to learn these concepts (Jones et al. Bloom et al., 2010; Nicolescu, 1997) through instructional strategies that incorporate higher order learning and transdisciplinary studies. Achieving this goal will require a reorientation of higher education that encourages higher order learning within instructor discourse, assignments, and assessments and a diversity of curriculum offerings across the social, economic and environmental domains of sustainability.

**Transdisciplinary Curricula**

**Disciplinary literacy**

In reference to terminology in higher education, “interdisciplinarity” has been described as “anything that goes beyond a single discipline” (Jones et al., 2010, p. 22). The authors contend that interdisciplinarity shares some commonality with the terms
“transdisciplinarity” and “multi-disciplinarity”: however, the terms are not universally defined and are often used interchangeably. Woods (2007) concurs that the term ‘interdisciplinary’ is inconsistent in regard to higher education initiatives. She suggests that:

If the intention is to enable students to engage in interdisciplinary communication in their future lives, it could be argued that developing ability in dealing with the complex negotiation of meaning and understanding should be one of the principal aims of interdisciplinary learning at university (p. 856).

In an effort to clarify these terms, Nicolescu (1997) argued that “interdisciplinarity” and “multi-disciplinarity” remain within the framework of research and classrooms in institutions of higher education, whereas transdisciplinarity is “globally open” (p. 3). Transdisciplinarity occupies the sphere of education but also encompasses knowledge of self and society. Borrega and Newswander (2010) share a similar perspective in regard to transdisciplinarity and sees the term as having a broader range of stakeholders, focusing on solving real-world problems through collaboration with practitioners and the public.

For the purposes of this research paper, these terms are used as defined in Chapter 1 and in the context of the articles from which they were drawn. However, regardless of definition, these terms all reflect a philosophy of reorienting higher education toward a holistic curriculum that extends across subject boundaries and concentrates on higher order cognitive skills. This focus is paramount to creating an informed and knowledgeable public (Kagan & Hahn, 2011; Cotton & Winter, 2010; Warburton, 2003).

**Transdisciplinary studies**

Apostel, Berger, Briggs, and Michaud (1972) called for interdisciplinary teaching and a “willingness to engage in dialogue and, hence, the capacity for assimilation and synthesis”
(p. 192), also known as higher order levels of learning. This approach has been advocated for education in sustainability by a number of authors specializing in the field of sustainability research. Squires (1992) saw the need for study across disciplines because it “creates the possibility of questioning, altering, or transcending those structures” (p. 201) in order to gain knowledge. Springett advocated education for sustainability that was holistic, interdisciplinary, multidisciplinary or transdisciplinary. Marinova and McGrath (2004) portray this crossing of disciplinary boundaries as the creation of a more comprehensive and holistic understanding of the world, leading to transdisciplinary knowledge.

Wright (2002) discussed a framework for sustainability in higher education programs that included the addition of interdisciplinary curriculum programs. The author cited the Tbilisi Declaration in 1977 as the first declaration that took “an international and holistic approach to the environment within a higher education context” (p. 7). The Thessaloniki Declaration, which followed in 1990, affirmed the need for a reorientation toward a more holistic approach to curricula in regard to environmental and sustainable development in formal educational settings (Wright, 2002). One of Moore’s (2005a) seven recommendations for creating sustainability education in post-secondary environments was to develop “collaborative projects within and between departments at the university (which do exist and flourish in some places) to create more time for reflection on important university priorities that cross disciplinary boundaries” (p. 332). The central purpose behind this was to break down some of the barriers to building interdisciplinary studies.

Nicolescu (1997), the founder of the International Center for Transdisciplinary Research and Studies (CIRET), promoted a transdisciplinary approach to teaching and research within higher education curricula. He posits that the evolution of learning must ask
critical questions and reject all “a priori answers and certitude contradictory to the facts” (p. 1). According to the author, transdisciplinarity must be part of pedagogical innovation and must be deeply rooted in imagination and sensitivity.

The viability of maintaining the balance of the ecosystem and the world economy, while managing issues such as societal inequities, global population surges, climate change, and a host of other global challenges, depends on education. These complex issues call for sophisticated solutions and extensive problem-solving processes across academic boundaries (Brundiers, 2009).

Higher Order Cognitive Processes

Cognitive process literacy

As with disciplinary literacy, there are a variety of overlapping terms that define complex thought processes. Warburton (2003) uses the term “deep learning” and considers it to be a significant pedagogical tool, especially in regard to sustainability education. The author associates the term with the “use of analytical skills, cross-referencing, imaginative reconstruction and independent thinking (p. 45). “Systems thinking” is described by Strachan (2009) as “an ability to analyze and recognize the interconnections within and between systems” (p. 84). Tsui (2002) described the basic elements of critical thinking skills as inferences, evaluation, and deduction and stated that “higher-order cognitive skills, such as the ability to think critically, are invaluable to students’ futures; they prepare individuals to tackle a multitude of challenges that they are likely to face in their personal lives, careers and duties as responsible citizens” (p. 1)

It is evident that the core characteristics of each of these terms coincide with the higher order cognitive levels of Bloom’s taxonomy. Subsequently, this research paper uses
the terms as defined in Chapter 1 and in the context of the articles from which they were drawn. As with the definitions involving transdisciplinarity, these terms all reflect a philosophy of reorienting higher education toward a holistic curriculum that extends across subject boundaries and concentrates on higher order cognitive skills.

**Promoting higher order learning**

Springett (2010) describes higher order cognitive thinking skills and transdisciplinary studies across the economic, social, and environmental domains as a change agent in preparing teachers and learners for the field of sustainability. Recent research in the field encourages this diversification of the concepts of sustainability in education and the integration of different knowledge from different disciplines in organizing university sustainability programs (Laws, Scholz, Shiroyama, Susskind, Susuki, & Weber, 2004). The authors see the role of the instructors, administrators, and program developers as designers of a holistic educational process that encourages students to achieve a higher level of cognitive reasoning.

Educational research studies in this area have been extensive, particularly in regard to higher cognitive skill assessment in agricultural education classes (Miller & Pilcher, 2001; Whittington, Stup, Bish, & Allen 1997; Ulmer & Torres, 2007; Whittington, 2008). The measurement tools for these types of studies have generally been a combination of Bloom’s Taxonomy (Bloom et al., 1956) and the Florida Taxonomy for Cognitive Behavior (Webb, 1970). These instruments have been validated in a significant number of research studies and are highly effective in defining the levels of cognitive progress, particularly higher order thinking skills (Ewing, 2006; Miller & Pilcher, 2001; Ulmer & Torres, 2007; Rover,
Mercado, Zhang, Shelley & Helvick, 2008). However, research studies have not focused on cognitive development in sustainability education.

The methods used to deliver this education must also be effective. Students should be given the opportunity to evaluate information critically in a supportive environment and to make decisions about complex issues, particularly in regard to sustainability (Cotton and Winter, 2010). Sustainability education should also allow students to explore and solve challenging problems in a transdisciplinary environment (Sherren, 2007). Burns (2011) notes that to provide sustainability education successfully, instructional strategies in post-secondary institutions must be transformed to address the complexity of our ecological system. In her view, traditional methods of pedagogy employed by universities “largely ignore ecological principles, and prepare learners to be successful in unsustainable cultural systems, thus perpetuating these systems of ecology” (p. 2). To correct these deficiencies in postsecondary settings, instruction must be integrated with non-traditional methods of teaching, including assessments that are positively correlated with student learning (Burns, 2011; Allen-Gil, Stelljes & Borysova, 2008; Tsui, 1999).

**Instructor Strategies**

An instructor can serve as a teacher, mentor, facilitator, or leader, and to some degree can create either a positive or negative tone in the classroom. The instructional methods and strategies that are employed during class and in the assignments can also have a positive or negative impact on students’ learning (Astin, 1993). Educators teaching at higher order cognitive levels can expect students to develop critical thinking skills to address complex and dynamic issues in their future professions (Hagedorn et al., 1999). A study by Smith (1977) found that three types of classroom interactions were consistently and positively related to
critical thinking skills (Tsui, 2002). These included positive interactions between the student and the faculty member, the frequency and cognitive level of student participation, and the peer-to-peer interactions among the students in the course.

In a similar study by Astin (1993), students’ leadership development, overall academic development, self-reported growth in problem solving skills, critical thinking skills, and cultural awareness were found to be positively correlated with student-to-student interaction. In 2000, Tsui conducted a case study of four schools and found that institutional growth in critical thinking was greater at the two schools using “an epistemological orientation that promoted cooperative exploration of knowledge and divergent thinking” (Tsui, 2002, p. 4). The findings of these studies indicated that instructors should encourage interactions through assignments involving group projects, engage students during discussions, and attempt to provide instruction at higher order levels of learning.

**Assessments**

Assignments and in-class discussions offer students the opportunity to develop higher cognitive skills in a self-motivated environment. Studies by Astin (1993), Tsui (2001; 2000; 1999) and Moore (2005a) suggest a positive relationship between critical thinking skills and specific assessment types. Astin (1993) and Tsui (1999) collected data from a national sample of college students and looked for self-assessed growth in critical thinking. Those studies revealed a positive correlation between critical thinking and the following methods:

- Having a paper critiqued by an instructor;
- Conducting independent research;
- Working on a group project;
- Giving a class presentation; and
• Taking essay exams (p. 2).

Within these studies, the findings also indicated a negative association between multiple-choice exams and self-assessed growth in critical thinking. One of the key disadvantages of multiple-choice tests is their inability to identify higher order learning skills. According to Thorkildsen (2005), multiple-choice outcomes describe little about the respondent’s ability to “identify the features of a problem, to organize and express ideas, or to synthesize information from more than one source” (p. 168). In contrast, respondents can be expected to analyze, synthesize, and evaluate information in essay question exam formats, allowing them to “fully reveal their skills or abilities” (Thorkildsen, 2005, p. 172).

Cooperative learning

Research findings also indicate that incorporating cooperative learning into assessments such as group projects or in a cooperative peer-to-peer learning situation encouraged the development of critical thinking skills (Tsui, 2001; 1999; Astin, 1993). Moore (2005a) suggested that pedagogical transformation can occur within higher education institutions if given the opportunity and space to do so. Her recommendation was for teachers to encourage and reward the following types of learning:

• Community service learning
• Participatory group learning/transformative learning
• Critical thinking/reflective learning
• Student-centered learning/problem-based learning
• Experiential learning (p. 331)

Results from Allen-Gil et al., (2008) mirror those of Moore (2005a). The authors’ research suggests that instructors and administrators within university settings should build
upon best practices in higher education through avenues such as experiential learning, service learning, project-based learning, and active learning.

Pascarella and Terenzini (2005) synthesized a series of research reports and categorized the Data Collection and Analysis sections. Findings indicated that cooperative or group learning had a positive influence on career-related skills such as leadership abilities, public speaking, ability to influence others, and ability to work effectively in groups. In addition, service learning was found to have a positive effect on “career development as self-ratings of leadership skills, the importance of a helping career, occupational identity processing, and salient career development tasks” (p. 542).

**Course objectives**

According to Linn et al., (2005), when designing course objectives, the instructor should first identify the course’s desired levels of learning outcomes through a cognitive instrument such as Bloom’s Taxonomy. The authors caution that the instructor must make special efforts at this stage by to incorporate objectives in the areas of understanding, application, thinking skills, and attitudes, which tend to be slighted in favor of knowledge objectives. Managing this step requires an analysis tool capable of distinguishing these learning objectives.

Bloom’s original taxonomy was developed to determine “the congruence of educational objectives, activities, and assessments in a unit, course, or curriculum (Krathwohl, 2002, p. 212). According to Krathwohl, one of the most common uses was to determine the curricular objectives’ depth or lack thereof in regard to the six levels (See Figure 1 for a comparison of Bloom’s six levels and the seven levels in the Revised Taxonomy). The author contended that the curricular focus is most often on the lower orders
of Bloom’s Taxonomy of Knowledge and Comprehension rather than the higher orders of Application, Analysis, Synthesis, and Evaluation.

In a study of agricultural faculty, Foster (2009) confirmed this finding, with approximately 62% of the course objectives focused on the lower levels of learning and 38% on the higher levels (p. 75). However, a 2005 study of pre-service teacher preparation courses by Ball and Garton showed that course objectives encouraged higher levels of cognitive learning. The authors found a majority of these course objectives at the Application (38%) and Synthesis (38%) levels (p. 63). This study performed a similar alignment analysis to determine the correlation between the intended cognitive levels of the course objectives and the instructor discourse for sustainability program courses. Additional discussion on the Ball and Garton study is included Chapter 4 - Results and Findings.

**Bloom’s Taxonomy**

Post-secondary education is a viable setting for measuring outcome assessments in sustainability (Davis, 2001; McKnight, 1990; Sherburn & Devlin, 2004; Segalas, Ferrer-Balas, Svanstrom, Lundqvist, & Mulder, 2009). This fertile environment is a natural repository for studying knowledge and in particular the perceptions of sustainability and sustainable development.

Segalas et al., (2009) conducted a study on students’ learned skills in sustainability using Bloom’s Taxonomy to determine the competencies levels in the cognitive, psychomotor, and affective objectives at three universities. The results of this study showed that the three universities followed a similar pattern in the classification of knowledge and understanding (cognitive), skills and abilities (psychomotor), and attitudes (affective) regarding sustainability.
Bloom’s Taxonomy (Bloom, et al, 1956) is used as a common instrument in agricultural research studies (Ball & Garton, 2005; Miller & Pilcher, 2001). Formally known as a concept of higher order thinking taken from the *Taxonomy of Educational Objectives, Handbook I: Cognitive Domain* (Bloom, et al, 1956), Bloom’s Taxonomy can be used to examine the learning progression of affective and psychomotor skills as well as the cognitive realm. Skill development in the latter area is categorized into six levels of progressively higher-order thought processes: Knowledge (the recall of facts and information), Comprehension (the basic understanding of information), Application (the utilization of knowledge and information to tasks), Analysis (the dissection of information and understanding of the relation of the parts to the whole), Synthesis (the compilation of information into a new concept or creation), and Evaluation (the making of judgments regarding the worth and value of information) (Ball & Garton, 2005).

The four upper levels (Application, Analysis, Synthesis, and Evaluation) are considered higher order thought processes (Bloom et al., 1956; Anderson et al., 2001), which are the recommended goal for most higher education courses (Ulmer & Torres, 2007; Ewing, 2006). The progression to higher order thinking, as defined by Lingard et al., (2001) “occurs when students manipulate information and ideas in ways which transform their meaning and applications” (p. 18). These various levels of cognitive behavior represent progressively complex skills in a hierarchical order (Webb, 1970). Subsequently, learners must acquire (lower order), comprehend and use (higher order), formulate (higher order), or manage the knowledge in some new method (higher order).
**Florida Taxonomy of Cognitive Behavior**

A significant number of research studies have used Bloom’s Taxonomy in conjunction with the Florida Taxonomy of Cognitive Behavior (FTCB), a derivation of Bloom’s Taxonomy (Rover et al., 2008; Ewing, 2006; Ball & Garton, 2005; Ulmer & Torres, 2005; Whittington, 2008; Miller & Pilcher, 2001; Whittington et al., 1997; Whittington & Newcomb, 1993; Pickford & Newcomb, 1989). The FTCB differs slightly from Bloom, et al (1956) in that it incorporates seven levels of learning versus six, and uses an observational setting with a score sheet to detect specific cognitive levels that are exhibited by the educator or achieved by the students.

Agricultural education colleges have made extensive use of this research method in analyzing the performance of online programs and professors’ perceptions of teaching levels (Miller & Pilcher, 2001); factors that aid in or detract from the learning process (Pickford & Newcomb, 1989); the aspired teaching levels versus assessed teaching levels (Whittington & Newcomb, 1993); modeling higher order thinking (Ball & Garton, 2005); and investigating characteristics that influence teaching at higher levels (Ulmer & Torres, 2007).

**Barriers to Change**

**Literacy obstacles**

Although the pursuit of sustainable development has drawn considerable interest in post-secondary schools, there are areas within this sector where the concept of sustainability is not fully understood (Filho, 2000). Some critics of the field, including university administrators, argue that curriculum built around the concept of sustainability may be unsuitable for colleges due to its ambiguous nature (Jickling, 2000). Jickling and Wals (2002) contend that if environmental thought is to evolve and the process is to involve
students, institutions must be careful not to “exclude a wide suit of emerging ideas in favor of a sustainability or sustainable development agenda” (p. 222).

The idea of providing for current generations without endangering the earth’s resources for future generations (Brundtland, 1987) has been described as contradictory, ambiguous, and vague by Daly (1996) and Gibson (2005). What began as a difficult concept to grasp in the Brundtland Report has become less tangible as various disciplines have adopted different definitions of sustainability to fit their field of focus. However, Gibson argued that this ambiguity gave the concept its universal acceptance and widespread recognition, noting that “an unambiguous and clearly subversive concept would have received a much more limited welcome” (2005, p. 39).

With the rapid growth of sustainability education and its filtration into virtually every career field, “this initial vagueness is no longer a basis for consensus, but a breeding ground for disagreement” (Daly & Farley, 2004, p. 3). The corporate sector is a prime example of changing the concept of sustainability to match their needs. As Springett (2010) noted, businesses moved more quickly than higher education in shaping the term of sustainability toward an economic focus. The author concluded that corporate influence has “played a part in relegating environmental and social issues to ‘externalities’ ” (p. 77), in essence making environmental devastation just another cost of doing business.

A study by Davis (2001) centered on perceptions of sustainability at two universities: Northern Arizona University in Flagstaff, Arizona and the University of South Carolina (USC) in Columbia, South Carolina. Qualitative interviews were performed with students from different majors to determine if the students’ education was holistic or more closely focused within one or two of the pillars of sustainability. Her findings indicated that
sustainability was consistently viewed more narrowly by students and typically addressed only the ecological meaning as a broad concept.

McKnight (1990) found a similar educational deficiency in a study of 200 college students majoring in business. “Comparatively, ES [environmental science] students were most ‘pro-environmental’ and ‘anti-technology,’ engineering students were most ‘pro-technology,’ and business students were ‘anti-environmental’ and ‘anti-technology’” (p. 137). His proposed solution was to “increase communication about the environmental and social impact of technology and science across all educational levels of the hard sciences” (as cited in Sherburn & Devlin, 2004, p. 24). Sherburn and Devlin (2004) confirmed the findings of McKnight (1990) and stated that there is reason to be concerned by the attitudes of students majoring in business-related subjects, who were more likely to focus on economy and “not [be] supportive of environmental issues” (p. 24).

**Transdisciplinary obstacles**

Consensus on the elemental perspectives of sustainability is only one of the impediments to implementing a holistic approach focused on higher cognitive levels of education. Warburton (2003) sees a pitfall in the implementation of sustainability education from the perspective of transdisciplinary studies. He cautions that one barrier to the creation of a transdisciplinary curriculum in sustainability is “the tendency for policy makers and practitioners to retreat back to [their] single discipline and [fail] to capture the holistic nature of problems and solutions” (p. 44). Part of this issue lies in the faculty’s research, publications, and other constraints included in the demands of tenure, which encourages specialization and concentrations in specific disciplines (Cortese, 2003). These policies often extend beyond the faculty, with departments focusing on one discipline rather than
promoting an interdisciplinary program of study across an expansive field of study (Moore, 2005b).

Blättel-Mink and Kastenholz (2005) also highlighted insecurity as one of the major barriers to an interdisciplinary focus on sustainability education. The authors conducted standardized surveys in German university research institutes and found that researchers were concerned about the security of their professions and felt insecure about straying into unfamiliar areas, even within the same field of research. This difficulty in abandoning the epistemological security in teaching within a professor’s respective discipline was also noted by Giddens (1995).

Jones et al., (2010) consider three principal inhibitors to meaningful curriculum change. Based on experiences with sustainability-related curricula and pedagogical development at universities and colleges, these inhibitors are:

1. “Academic staff, jealously guarding their academic freedom, see education for sustainable development as an imposition, something not commensurate with their discipline or student expectations of their discipline. Steeped in their specialism, they are uncomfortable about the interdisciplinary teaching for which the multi-dimensional concept for sustainability calls. They see no rewards or career advancement in sustainability curriculum innovation” (p. 9).

2. “Academic staff, both converts and contrarians, consider themselves as lacking the knowledge and skills, expertise, and experience to implement sustainability-related teaching and learning” (p. 10).
3. “Academics and administrators hold that the ethos of the institution is not favourable for successful integration of sustainability across the teaching and learning programmes of the institution” (p. 10).

In order to overcome these barriers in the future, sustainability education must become a productive and viable program that focuses on transdisciplinary studies and critical thinking as integral parts of the curriculum. An assessment survey conducted by the University Leaders for a Sustainable Future (ULSF) indicated that a college or university that is committed to sustainable education should “appropriately incorporate the concepts of sustainability into all academic disciplines and in liberal arts and professional education requirements [and have] a firm grounding in basic disciplines and critical thinking skills [which are] essential to pursuing a sustainable future” (Calder, 2008, p. 1).

The International Review for Environmental Strategies states that education “requires a long term perspective, a comprehensive understanding, and a care for the future generations” (p. 2). Warburton also shares this insight. In his article, *Deep Learning and Education for Sustainability* (2003), the author emphasizes that an interdisciplinary approach and systems thinking are essential in sustainability and sustainable education. He further states that the interconnection between environmental, social, and economic issues is of critical importance, as are interdisciplinary thinking, holistic insight, and deep learning. This is particularly relevant in the context of education for sustainability.

Only a small percentage of the literature is focused on potential barriers or pitfalls of sustainability education programs (Jickling, 2000; Jones et al., 2010b). Many university leaders believe they have the opportunity to integrate a broad base of core concepts into their programs with a focus on higher order learning skills (Moore, 2005b). If this holds true, the
ability to educate students within transdisciplinary circles at higher levels of learning (Hopwood, Mellor, & O’Brien, 2005; Gibson, 2005; Dale & Newman, 2005) will create a responsible, empowered, and productive community (Newman, 1990) that is capable of creating a sustainable paradigm of economic, environmental, and social imperatives (Dale & Newman, 2005).

**Summary**

There has been a continual call for transdisciplinary post-secondary education programs since the Brundtland report introduced the modern definition of sustainability in 1987. Marinova and McGrath (2004) recommended that universities make a concerted effort to design a transdisciplinary approach: “An education in sustainability increases awareness of the complexity and interrelationships of environmental, economic, social, political and technical systems which can be achieved through a transdisciplinary approach to teaching and learning” (p. 1). Research by Sherren (2007) supported this perspective and indicated the need for a sustainability canon in undergraduate sustainability programs. She argued that the absence of accreditation standards or at least guidance from experts in the field would result in “unrestrictive cafeteria-style programs” (p. 341) rather than those that provide the capacity to deal with sustainability issues.

Evidence indicates strong support for a transdisciplinary approach to sustainability education in post-secondary institutions, which could holistically address the economic, environmental, and social dimensions of sustainability (Moore, 2005a; Blättel-Mink & Kastenholz, 2005; Dale & Newman, 2005; Davis, 2001). There are also substantial data that indicate a pedagogical need for the development of new curricula and practices to develop higher order learning skills in sustainability education (Warburton, 2003; Filho, 2000; Dale
& Newcomb, 2005). Previous studies in the field of agricultural education have found a deficiency in students’ achievement of the higher order levels of cognitive knowledge. Similarly, some institutions fail to examine the multidimensional nature of sustainability. This study provided new insights into underexplored areas, and may assist the creation of specifically directed sustainability programs and degrees.
CHAPTER 3 - METHODOLOGY

This chapter outlines the methods that were used to obtain data for the study and the methods used in the analysis of these data.

Purpose of the Study

The purpose of this study was to describe, assess, and compare the measured cognitive level of instruction, course objectives, instructional strategies, assessments, and the transdisciplinary nature of two post-secondary sustainability education programs. Instructional strategies in these programs included such methods as class presentations, group activities, and interaction with students. The research design was a descriptive-correlational multi-case research study (Creswell, 2008).

Research Objectives

The following research objectives were used to explore and analyze the problem and to guide the research study:

1. Describe the demographic characteristics related to each instructor’s years of teaching experience and position(s) held.

2. Describe the transdisciplinary nature of the curriculum in sustainability degree and certificate programs relative to the social, economic, and environmental domains of sustainability.

4. Determine the difference between sustainability instructors’ percentage of time spent at each cognitive level through instructor discourse and those of agricultural and pre-service teachers measured in previous studies.
   
a. $H_0$: There is no difference between sustainability instructors’ percentage of time spent at each cognitive level and pre-service instructors’ percentage of time spent at each level.

5. Describe the characteristics of the classes (number of students, student to teacher ratios, instructional plans, gender diversity, and interactions between students and instructor).

6. Describe the instructor strategies employed to achieve higher order levels of learning in class.

7. Determine the cognitive level of course objectives and assessments and compare them against the cognitive levels of instructor discourse.

**Research Design**

The research design for this project was an embedded case study method using descriptive-correlational analysis. Observations were performed in four classes on multiple occasions using quantitative and qualitative methods concurrently. According to Yin (2009), some embedded case studies represent this form of mixed method design. These studies rely on holistic data collection techniques for the main study but use more quantitative techniques to analyze embedded data. An example by Creswell (2008) described studying the activities of a pre-school class with qualitative data while using a checklist to collect quantitative data, in essence the same type of method employed in this research study. The case study
methodology has been used successfully in sociological studies and in the area of instruction (Tellis, 1997).

Mixed method studies are used when the methods of quantitative and qualitative analysis in combination provide a better understanding of the research problem by building on the strengths of each method (Creswell, 2008). The mixed method study “consists of merging, integrating, linking, or embedding the two ‘strands’ [of research]” (p. 552) and provides a rich and comprehensive understanding of the subject. Triangulation captures both quantitative data, which provide for generalizability, and qualitative data, which gather information on context or setting.

When Tsui (1999) researched the impact of instructional factors, she applied qualitative methods to tap multiple sources of data, but found few studies on critical thinking in higher education settings that used qualitative methods. She attributed this to a lack of qualitative measures on specific teaching techniques or strategies: “limited efforts to investigate the effects of specific teaching techniques may stem from the difficulty of attaining direct indicators; studies that address classroom experiences tend to rely on self-reported data rather than observational data” (p. 2).

**Population and Sampling**

The target population for this study consisted of professors who teach in sustainability programs offered at institutions of higher education. Demographic data was gathered from interviews and the respective universities’ websites. The sampling frame for the post-secondary schools was selected from a list of 23 schools (“Master’s Degrees”, n.d.) offering graduate degree programs and eight graduate programs offering certificates (“Graduate Certificates”, n.d.). A copy of the full list is included in Appendix A. The list of universities
and colleges was produced and posted online by the Center for Sustainability at Aquinas College (Masters Degrees, n.d.; Certificates, n.d.). The Aquinas College list was chosen as the sampling frame in 2010 due to its reputation as a clearinghouse for sustainability education programs.

Located in Grand Rapids, Michigan, the Center for Sustainability at Aquinas College (C4S) is a student-run and faculty-directed organization providing a web-based clearinghouse of information for consumers, business people, non-profit organizations, students, and governmental agencies interested in sustainable practices. The Center is located at Aquinas College, the first institution in the United States to offer undergraduate degrees in sustainable business. In addition to collecting and disseminating information, the Center also conducts conferences and workshops, maintains an extensive list of publications on sustainability, and organizes the Campus Sustainability Initiative at Aquinas (Center for Sustainability-About the Center, 2012, para. 1).

The first sample of five universities (n=5) was purposely selected from a combination of the two lists of universities with sustainability programs. Recruitment of professors was unsuccessful for two of the selected universities, and a third university dropped out after IRB approval but before data collection had started. Permission to conduct the study was obtained from the IRB at Iowa State University and from Arizona State University’s School of Sustainability and Portland State’s Institute for Sustainable Solutions.

The final sample consisted of three instructors teaching a total of four courses: two professors from Arizona State University (ASU) and one professor teaching two courses from Portland State University (PSU). The instructors at ASU both taught undergraduate
courses within the curriculum of the bachelor’s degree program at the Institute of Sustainability. The instructor at PSU taught in the graduate certificate program at the Institute for Sustainable Solutions. The teaching evaluation was conducted through direct observation in these four courses at ASU and PSU with one to four visits to each class during the fall and winter semesters.

**Research Location**

Locations to conduct interviews with the faculty were arranged in advance. The interviews and observations took place on the respective university campuses and by telephone. Campus interviews were conducted in the professors’ offices prior to classes but outside of office hours to avoid interruptions. The faculty members were contacted ahead of time and asked to select convenient times for the interviews. Miles and Huberman (1994) suggest pre-structuring an interview to streamline the coding and analysis process. This was done prior to conducting the interviews with copies of the basic questions emailed to the professors in advance of the interview. Additional follow-up questions were added spontaneously to clarify or expand upon the responses given. The interview questions are included in Appendix D.

**Instrumentation**

Tools used to gather the data included FTCB score sheets, digital camcorders, permission sheets, and handwritten notes. All data were analyzed using the SPSS for Windows computer program.

The qualitative portion of this study analyzed the transdisciplinary content and cognitive learning levels for each course by examining course content and instructional strategies, and by conducting interviews. Class observations were used to document class
participation and student engagement with peers and instructors, three elements that have a positive effect on critical thinking (Astin, 1993). Instructors were interviewed to determine the method of selection and processes for adding and revising the curriculum. All interview transcripts, course catalogs, and observational notes were carefully reviewed and conclusions were drawn from these data sources.

**Florida Taxonomy of Cognitive Behavior**

The instruments employed for the quantitative segment of this research were the Florida Taxonomy of Cognitive Behavior (Brown, Ober, Soar, & Webb, 1974) and Bloom’s Taxonomy (Bloom et al., 1956). The FTCB has been widely used and is well recognized for this type of data collection.

The FTCB provides a framework for observing and recording the cognitive behaviors of teachers and students in the classroom. The system can be used directly by an observer in the classroom to assess the cognitive level of functioning of teachers and students: knowledge level, translation (paraphrase, express graphically, etc.), application, analysis, synthesis and evaluation. (Simon and Boyer, 1974, p. 203). The FTCB is based upon Bloom’s Taxonomy (Bloom et al., 1956) and was used in this project to measure the potential level of cognition exhibited in instructor discourse in multiple classes for each course that was observed. The score sheet is divided into ten six-minute observation periods (to coincide with an hour-long class session) and is administered by a rater who observes the instructor discourse. A copy of the FTCB score sheet is included in Appendix E. Each time during the six-minute period that the teacher achieves a particular cognitive level of instruction, it is recorded with a checkmark in the corresponding box for that level.
The cognitive levels of instruction were derived from courses selected from the core curriculum at each university. The instructors’ discourse, course objectives, and assignments were evaluated in reference to their cognitive levels of instruction. Three classes were recorded and re-evaluated three weeks after the class to validate the accuracy of the data collection procedures of the sole researcher. The results of this analysis were derived from the Pearson Product-Moment Coefficient. The average reliability score was \( r = 0.97 \).

**Data Collection**

Data on the following activities were collected using the described instruments and methods.

**Transdisciplinary studies**

A program that crosses disciplinary tracks of education brings consilience to sustainability education. It exposes students to diverse perspectives that promote systems thinking and forms a foundation for the student’s further education, career, or lifestyle (Moore, 2005a). For this phase of the research, two of the participating professors, one of which was also in administration, were interviewed to determine the process for selecting, writing, and approving curricula for inclusion into the sustainability programs.

Course descriptions obtained from university catalogs were reviewed to determine the required courses and electives of the sustainability programs and identify the approximate distribution of classes focused on the social, economic, and environmental domains of sustainability. Additional documentation was obtained from class syllabi and university websites. Interviews were conducted with instructors to determine the process for curriculum course development at their respective institutions, the process of revising courses and degree requirements, and the roles of the administration and instructors in each.
This exploratory research related directly to the assessment of the transdisciplinarity of the programs being studied. The results show the positive and negative aspects of the curricula in regard to the holistic nature of the program offerings and translate directly to benefits for the administrators, instructors, and students involved in the degree programs that were examined.

**Instructor discourse**

Instructor discourse was measured during each class session using the FTCB score sheet. The appropriate level was checked when terms associated with a specific level of cognition (knowledge, interpretation, translation, application, analysis, synthesis, or evaluation) were used during an instructor’s discourse. Discourse may have been related to questions, discussion, analytical references, assigned tasks, or another form of inquiry.

For the samples in this study, class times ranged from 75 minutes to 150 minutes. Data were collected for one 60-minute session during each of the 75-minute classes and for two 60-minute sessions for the 150-minute classes. After each session, the data were tabulated and coded for future analysis. Qualitative data collection methods were also used while the class observations were conducted (Astin, 1993).

Cognitive behaviors were scored as indicated previously and the total number of observed behaviors was summed for each cognitive level. The frequency of occurrence for a given level was recorded as a percentage of the total number of cognitive behaviors. These percentages were then multiplied by a weighting factor developed by Newcomb and Trefz (1987) to provide a cognitive weighted score for each level observed during the classes. The weighting factor compensates for the level of processing required for higher order learning skills. The cognitive weighted scores for each level were then totaled to produce a final
cognitive weighted score for each class and for each professor. The range of values for the
cognitive weighted score must fall between 10 (indicating instruction only at the knowledge
level of learning) and 50 (indicating instruction only at the synthesis or evaluation level).
Table 3 shows a sample tabulation of the cognitive behaviors encouraged by the instructor
during his or her series of observed classes. In this example, instruction at the knowledge
level occurred 38 times out of 149 total teaching behaviors. This indicates that the instructor
spent approximately 25.5% (38/149) of his or her class time teaching at the knowledge level.
To obtain the weighted scores, the raw percentage of 25.5% was then multiplied by the
weighting factor to give a total of 2.55 for the knowledge level. This process was repeated
with each level of cognition, multiplied, and then tallied under the cognitive weighted score
column. The final total of 27.10 indicates that the instructor for this class generally taught
between the comprehension level (20) and the application level (30).
Table 3: Sample calculation of total cognitive weighted score for instructor discourse

<table>
<thead>
<tr>
<th>Bloom's Level</th>
<th>Total Observations</th>
<th>% of Behavior</th>
<th>Weighting Factor</th>
<th>Cognitive Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>38</td>
<td>25.5%</td>
<td>0.10</td>
<td>2.55</td>
</tr>
<tr>
<td>Comprehension</td>
<td>36</td>
<td>24.2%</td>
<td>0.20</td>
<td>4.84</td>
</tr>
<tr>
<td>Application</td>
<td>28</td>
<td>18.8%</td>
<td>0.30</td>
<td>5.64</td>
</tr>
<tr>
<td>Analysis</td>
<td>25</td>
<td>16.8%</td>
<td>0.40</td>
<td>6.72</td>
</tr>
<tr>
<td>Synthesis</td>
<td>16</td>
<td>10.7%</td>
<td>0.50</td>
<td>5.35</td>
</tr>
<tr>
<td>Evaluation</td>
<td>6</td>
<td>4.0%</td>
<td>0.50</td>
<td>2.00</td>
</tr>
<tr>
<td>Totals</td>
<td>149</td>
<td></td>
<td></td>
<td>27.10</td>
</tr>
</tbody>
</table>
Cognitive level of course objectives

A copy of the syllabus was obtained from each of the four classes that were observed for this study. Within these syllabi, the cognitive level of each objective was analyzed and classified according to the key words written in developing the objectives. The two sources used to categorize the level of each objective were Bloom’s Taxonomy (Bloom et al., 1956) and Action Verbs for Creating Learning Outcomes (Anderson et al., 2001). A copy of each of these sheets is included in Appendix F and G, respectively.

Each course objective was first analyzed using the action verbs from Bloom’s Revised Taxonomy. The revised taxonomy used the same six-level cognitive process dimensions as Bloom’s original taxonomy; however, there were two significant changes in the revision that warrant attention (see Figure 2). The level of Synthesis (Level 5 in Bloom’s original taxonomy) was changed to Create and was moved to the highest level (Revised Level 6). The authors state that Evaluation is a lower order process than Create because it involves “putting elements together to form a coherent or functional whole” (p. 84), whereas Evaluate requires “making judgments on criteria and standards” (p. 83).
The remainder of the cognitive process dimensions remained in the same order, but the names were changed from nouns to verbs. The reason for this revision was that objectives should indicate something “students should be able to do something (verb) to or with something (noun)” (Anderson et al., 2001, p. 265). Figure 2 shows the revised framework changes to the original taxonomy.

To finalize the categorization, the course objectives from the revised version were coded according to Bloom’s original taxonomy, including the corresponding level order and names.

**Assessments**

Assessments included homework assignments and in-class assignments such as small group work, class discussions, or presentations. These assessments were evaluated on the intended level of higher order cognitive behavior using both quantitative and qualitative data.
collection methods. Homework assignments were evaluated using quantitative methods to determine the level of cognitive skills required to complete the assignment successfully. Each homework assignment in the syllabus was assigned a percentage of the total class grade and a description of the tasks necessary to complete the work. Each description was evaluated using action verbs from Bloom’s Revised Taxonomy to determine the level of cognitive thought required to complete the assignment.

Qualitative methods were also used to assess homework based on a number of studies that suggested a positive relationship between critical thinking skills and specific assessment types (Thorkildsen, 2005; Moore, 2005a; Tsui, 2001; Astin, 1993). According to the authors, the following assessments encourage higher order learning skills:

- Having a paper critiqued by an instructor;
- Conducting independent research;
- Working on a group project;
- Giving a class presentation; and
- Taking essay exams.

Research also indicated that the development of higher order thinking skills was associated with in-class activities such as group work, interaction with an instructor or peers, experiential learning, and critical reflective thinking, as well as outside assignments such as community service learning projects.

Data for this phase were drawn from the syllabi. Each was reviewed and analyzed for information on learning objectives, outcomes, and content. As with the course objectives, action words from Bloom’s Taxonomy were used to determine the intended learning level for each assessment outcome.
Demographic data were collected from each instructor along with data regarding their intended objectives and teaching content. Each interview was informal but was conducted with the same questions for each instructor. The discussions were transcribed immediately after the interviews except in those cases when class observations took place shortly after the interviews. In addition to the demographic questions, discussions were directed toward content in the syllabus for clarity and information regarding the sustainability domains that were taught in the classes.

Data Analysis

Data were analyzed for each of the following phases of research and are described as follows. Both qualitative and quantitative methods were employed.

Transdisciplinary studies

The first phase of data analysis was a qualitative examination of the transdisciplinary nature of the courses being taught at each university. The universities’ course catalogs and program descriptions for the core courses for the BA and BS sustainability degree programs at ASU and the graduate certificate in sustainability program at PSU were evaluated for course content. The analysis examined the course credit hours and the inclusion of the economic, environmental, and social domains of sustainability based on the course descriptions. The data were tabulated with column headings for the course number, course title, credit hours, and the sustainability domains addressed in the course. After examining the descriptions, course credits were distributed evenly if all three of the domains were present in the instruction of the course, were divided by two if any two domains were present, and were placed in the economic, environmental, or social column if the course focused solely on only one discipline. The final distribution of the core courses was listed as
a percentage of the total required hours. As an example, the Sustainable Development Practices course at PSU (USP 588/688) is a three-credit-hour course. Based on the description, this class emphasizes interdisciplinary studies in the economic, environmental, and social domains and would receive one credit in each column.

The elective courses at Arizona State University were not evaluated due to the diversity of the electives. Each student within the two degree programs has the option of taking electives from a variety of courses within their respective majors, which would make any attempted analysis biased in favor of that program (i.e. business, environmental sciences, etc.). However, the 11 required core courses totaling 33 credit hours were examined for transdisciplinary content. Furthermore, a description of the overall programs accompanies the analysis of the two degree programs at ASU and the graduate certificate program at PSU.

**Instructor discourse**

The second phase of the study was a descriptive quantitative analysis. In-class observations were made on multiple occasions for the four classes studied and were intended to gather data on higher order cognitive behavior. Analysis for this phase consisted of independent $t$-test analysis, frequencies, means, and standard deviations.

Quantitative data were drawn from lectures using the Florida Taxonomy of Cognitive Behavior score sheet and the descriptive statistics for each level were analyzed. The procedural aspects of this instrument were described in the Data Collection section of this chapter. The primary variable being measured for this instrument was the discourse (lecture, focus groups, or other conversations) of the instructor and students during class. For this phase of the research, the frequencies observed within each level of cognition were totaled. The summed totals from each teacher’s observations were divided by the grand total of their
observed behaviors, to arrive at a percentage for each cognitive level (Knowledge, Interpretation, Translation, Application, Analysis, Synthesis, and Evaluation). The means, standard deviations, and ranges were calculated and comparisons between the three instructors were discussed.

A comparison analysis was also performed. The means of instructor discourse for the ASU and PSU sustainability courses were compared to two previous studies that used the FTCB instrument. The first comparison was between sustainability instructors at Arizona State and Portland State Universities and a study by Ball and Garton (2005). Ball and Garton’s sample consisted of seven educators at University of Missouri teaching secondary and middle school education majors. The means for each level of cognitive behavior were tabulated and compared to the cognitive levels of teaching. A two-tailed independent t-test was used to determine if there was a statistically significant difference between the two sample means of instructors using the data from the FTCB. The t-test was used because there were only two groups for comparison and the sample size was small (Agresti & Finlay, 2009). Since Ball and Garton’s study used the six levels of Bloom’s Taxonomy, an adaptation was made to the data table for the ASU and PSU sample to compensate for the differences between the Comprehension level in Bloom’s Taxonomy and the Translation-Interpretation levels in the FTCB. In counts taken for classes in this research study, Comprehension was checked only once for each six-minute period if the box for either Translation or Interpretation was checked.

The second quantitative analysis compared the means of instructor discourse of the ASU and PSU sample to a 1989 study by Pickford and Newcomb. Pickford and Newcomb’s sample consisted of three agricultural teachers at Ohio State University and used the seven
levels of the FTCB versus the six levels of Bloom’s Taxonomy. Separate $t$-tests were used for each of these comparison studies and the differences in the means of the cognitive levels of instructor discourse were analyzed for significance at the 0.05 level. The null hypothesis $H_0$ (there is no difference) was rejected when the observed $t$-value was in the critical region of the normal curve for each analysis.

**Course objectives**

The course objectives of each of the four classes were taken from the syllabi, which were obtained from the professors prior to interviews. Cognitive levels for each objective were determined using Bloom’s Taxonomy (Bloom et al., 1956) and Bloom’s Revised Taxonomy (Anderson et al., 2001). To create a single cognitive score for the course objectives, weighted values were assigned to each level of cognition to get a composite score. Since each objective could contain multiple levels in regard to the intended cognitive goals, only the highest level in the hierarchy was used for each respective objective. As an example, if an objective used the verbs “analyze and evaluate” when describing a concept, that objective would be considered at the level of Evaluation.

The percentage value of each objective was based on the total number of objectives outlined in each syllabus and was calculated by dividing the number of goals by 100. If the syllabus contained five goals, the percentage for each goal was calculated as 20%. The representative percent for each cognitive objective was multiplied by the cognitive weighted values attributed to each level of cognition. Each value derived from this process was then summed to attain a total cognitive weighted score for each course. The tabulation for this analysis is shown in Table 4.
Table 4: Sample calculation: weighted cognitive levels of course objectives

<table>
<thead>
<tr>
<th>Course Objective</th>
<th>% of Course Objectives</th>
<th>Cognitive Levels</th>
<th>Cognitive Wt.</th>
<th>Cognitive Wt. Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20.0%</td>
<td>Knowledge</td>
<td>0.1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>20.0%</td>
<td>Comprehension</td>
<td>0.2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>20.0%</td>
<td>Application</td>
<td>0.3</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>20.0%</td>
<td>Analysis</td>
<td>0.4</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>20.0%</td>
<td>Analysis</td>
<td>0.4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>100.0%</td>
<td></td>
<td></td>
<td>28</td>
</tr>
</tbody>
</table>

Descriptive statistics for the cognitive levels of course objectives were calculated and compared to the levels of instructor discourse from the FTCB as well as the cognitive levels that the assessments targeted.

Assessments

Assessments were analyzed through quantitative and qualitative methods. The quantitative analysis was conducted similarly to the method used for course objectives. Assignments were derived from the syllabi for each of the four courses. Cognitive levels for each objective were then determined using Bloom’s Taxonomy (Bloom et al., 1956) and Bloom’s Revised Taxonomy (Anderson et al., 2001). To create a single cognitive score for the assignments, weighted values were assigned to each level of cognition to get a composite score. The highest level in the hierarchy noted in the description was used for each respective assignment. The percent value of assignments was drawn from the course syllabus. If an assignment was given in multiple parts, a cognitive score was calculated for each of the parts at the appropriate percentage. As with the course objectives, the
representative percent for each cognitive objective was multiplied by the cognitive weighted values attributed to each level of cognition. Each value derived from this process was then summed to attain a total cognitive weighted score for each course. The tabulation for this analysis is shown in Table 5.

Descriptive statistics for the cognitive levels of course objectives were calculated and compared to the levels of instructor discourse from the FTCB and the cognitive levels that the course objectives targeted.

Table 5: Sample calculation: weighted cognitive levels of assignments

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Cognitive Level</th>
<th>Cognitive Wt.</th>
<th>Overall % of Grade</th>
<th>Wt. Cognitive Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analysis</td>
<td>0.4</td>
<td>15.0%</td>
<td>6.0</td>
</tr>
<tr>
<td>2</td>
<td>Application</td>
<td>0.3</td>
<td>20.0%</td>
<td>6.0</td>
</tr>
<tr>
<td>3</td>
<td>Analysis</td>
<td>0.4</td>
<td>35.0%</td>
<td>14.0</td>
</tr>
<tr>
<td>4</td>
<td>Comprehension</td>
<td>0.2</td>
<td>15.0%</td>
<td>3.0</td>
</tr>
<tr>
<td>5</td>
<td>Analysis</td>
<td>0.4</td>
<td>15.0%</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100.0%</td>
<td>35.0</td>
</tr>
</tbody>
</table>

Concurrent with the classroom observations for the instructor discourse, an embedded study of student engagement and instructor strategies for class were conducted. A review of all interview transcripts and syllabi were also analyzed to document the inclusion of in-class assessments that encouraged the development of higher order thinking skills. Observations during class were noted in reference to in-class activities as well as group activities that took place out of the classroom. These included experiential learning and service learning
projects such as Portland’s Learning Garden Laboratory\textsuperscript{1}, (Learning Garden, 2012, para. 1) which was an assignment in one of the classes at Portland State University.

**Validity**

“Validity for this instrument was based upon its direct development from Bloom’s Taxonomy and the support generally given to this hierarchy of cognitive behaviors” (Whittington, 2008, p. 60). Reliability for the sole reviewer was checked by recording three classes of lectures and reviewing the three tapes for consistency three weeks later. The Pearson correlation coefficient was calculated for $r$ by reviewing the three tapes and comparing the scores with those of obtained during the corresponding observation of each class. A mean value of $r = 0.97$ was obtained from this calculation.

Validity can be generally described in research science as an indication of whether the research accurately reflects or assesses what was intended or if the results are true. Maxwell (2005) discusses bias and reactivity as two threats to validity in qualitative analysis and proposes methods for reducing or compensating for them.

In any study, bias may be present in the selection of the research participants or in the interpretation of the data based on the researcher’s own college experiences or any number of other factors. Since this was a purposefully selected sample based on willingness to participate, bias in selection was not considered to be an issue.

Soliciting feedback from the respondents can aid in reducing the misinterpretation of answers that occur during the interview as well. During this study, the professors were asked

\textsuperscript{1} The Learning Garden Laboratory (LGL) is a 12-acre garden education site located in Southeast Portland that provides K-12 students, university students and community members hands-on and place-based education in sustainable gardening, healthy nutrition, and permaculture. Education at LGL supports improved academic achievement, leadership development, and the development of sustainable local food systems.
follow-up questions and asked to clarify uncertainties or confusing statements during the interview to insure that their intent was clear.

Since it is not possible to eliminate reactivity, it must be compensated for. My intent was to create a relaxed, friendly, and informal setting for the interview and to provide an atmosphere of rapport and trust. The natural setting for the professors (on their own campus within the individual’s major department of study) reduced the possibility of reactivity.

**Ethics**

The professors involved in this project remain anonymous, since the purpose of this study was not to determine the ability of a specific educator’s performance, but to serve as a research study on the general field of sustainability education. Professors were purposefully selected and received an informed consent form which was signed before they were allowed to participate in the study.

Full disclosure was given with regard to the purpose of the study and its intended use. Before any questions were asked, all participants were told that this study was performed as part of the researcher’s PhD program requirements. The researcher was explicit in the intent to use this information in his dissertation and potentially in future publications. However, the interviewees were also made aware that their names would not be used in any published work. Each instructor received a numbered code for tabulation and there was only be a minimum description of the demographic data for each respondent.
CHAPTER 4 - RESULTS AND FINDINGS

Population and Data Collection

The first sample of five programs was purposely selected from a combination of two lists of universities offering sustainability degrees and certificates. Recruitment of professors was unsuccessful for two of the selected universities and a third university dropped out before data collection began, leaving a sample of three instructors (n=3) who taught a total of four courses. Moore (2005b) described similar challenges in her work on sustainability:

Ideally, I would have had full enough participation from enough people to name my work ‘participatory action research’. Unfortunately, faculty members and administrators are extremely busy and it was difficult to find people on campus with enough time to engage in this study (p. 540).

Observations of the three instructors consisted of two to four visits in each of four courses during the fall 2012 and spring 2012 semesters at the two universities. A total of 16 hours of qualitative observation was conducted focused on instructor strategies and teaching methods. Quantitative analysis was conducted concurrently but only during 12 of the 16 hours of class observations. Since the procedure for the FTCB involves measurement periods of 60 minutes (ten 6-minute segments) and class periods were 75 minutes, qualitative data were not collected during the entire class periods (Brown et al., 1970).

Additional data collection included a comprehensive review for the subject universities’ programs that evaluated the transdisciplinary core and course requirements and electives, specifically the inclusion of social, economic, and environmental elements in the pedagogy. Interviews were also conducted with two of the participating professors (one at each university) at the conclusion of the data collection stage regarding the transdisciplinary
nature of the courses, curriculum development, and instructor strategies employed in the classes.

**Research Objectives**

The following research objectives were used to explore and analyze the problem and to guide the research study:

1. Describe the demographic characteristics related to each instructor’s years of teaching experience and position(s) held at the university.

2. Describe the transdisciplinary nature of the curriculum in sustainability degree and certificate programs related to the social, economic, and environmental domains of sustainability.

3. Determine the cognitive level of in-class discourse delivered by the professors using the Florida Taxonomy of Cognitive Behavior

4. Determine the difference between sustainability instructors’ percentage of time spent at each cognitive level through instructor discourse and agricultural and pre-service teachers’ percentage of time at each cognitive level as measured in previous studies.
   a. $H_0$: There is no difference between sustainability instructors’ percentage of time spent at each cognitive level and agricultural and pre-service instructors’ percentage of time spent at each level.

5. Describe the characteristics of the sustainability classes (number of students, student to teacher ratios, instructional plans, gender diversity, and interactions between students and the instructor).

6. Describe the instructional strategies employed to achieve higher order levels of learning in class.
7. Determine the cognitive level of course objectives and assessments and compare them to the cognitive levels of instructor discourse.

Results and findings are written in the order of objectives as formerly listed. The quantitative results for each objective (if applicable) are discussed first with the qualitative findings (if applicable) following.

**Demographic Characteristics**

The sample for the demographic data collection consisted of three instructors teaching a total of four classes (n=4) in two post-secondary institutions’ sustainability programs. Two instructors in the sample taught undergraduate courses at Arizona State University and one instructor taught graduate courses at Portland State University. Two of the instructors were female and one was male. All three instructors had obtained their doctorate degrees, with two serving as assistant professors and one serving as a full professor. Two of the three instructors taught undergraduate classes for the Arizona State University Global Institute of Sustainability but were assigned to other departments of the university. The instructor for the Portland State University program was a Sustainability Scholar who taught graduate classes for the Institute of Sustainable Solutions but was also assigned to another department. The range of teaching experience at post-secondary schools ranged from 12 to 15 years, with each instructor spending approximately half of that time dedicated to sustainability education.

**Transdisciplinary Studies**

A close examination of the conceptual literature leads one to the conclusion that sustainability is complex and multi-dimensional (Portney, 2003). Subsequently, any effort to educate the public about the concept of sustainability and more importantly the resolution of
problems in the environmental, economic, and social domains must include instruction across these dimensions. For each university, course descriptions and program requirements were obtained from the respective institutions’ websites and reviewed for content. For purposes of this cross-sectional study, the 2011-2012 school year was used as the benchmark for course offerings and degree requirements.

**Arizona State University**

ASU’s School of Sustainability (SOS) offers students two degrees, a Bachelor of Arts or a Bachelor of Science in Sustainability. Graduation requirements for each degree include two prerequisite classes, 15 hours within the core curriculum or Challenge Area Courses, and elective courses within a track of the student’s choice. The prerequisites for both degree programs and the Challenge Area courses include the following:

- SOS 110: Sustainable World (prerequisite)
- SOS 111: Sustainable Cities (prerequisite)
- SOS 320: Society and Sustainability
- SOS 321: Policy and Governance in Sustainable Systems
- SOS 322: International Development and Sustainability
- SOS 323: Sustainable Urban Dynamics/SOS 465: Smart Growth and New Urbanism
- SOS 324: Sustainable Energy, Materials and Technology
- SOS 325: The Economics of Sustainability
- SOS 326: Sustainable Ecosystems
- SOS 327: Sustainable Food and Farms
- SOS 394: Sustainability and Enterprise
A course description of the prerequisite courses and all of the Challenge Area courses is included in Appendix H.

**Bachelor of Arts**

According to the *Arizona State University School of Sustainability Undergraduate Handbook, 2011-2012* (2011):

The B.A. program introduces students to the concept of sustainability in the context of real-world problems, exploring the interaction of environmental, economic, and social systems. This degree is best suited to students inclined towards social sciences, humanities, planning, and related fields. (p. 8).

The SOS provides students with the option of four different tracks within the BA degree in sustainability.

1. The Society and Sustainability track “explores the human, social, and cultural aspects and perspectives on sustainability challenges and related problem-solving approaches” (p. 9). This track favors the social domain of sustainability based on its description and course requirements.

2. The Policy and Governance track “explores the theoretical and empirical literature on governance, learning how international, national, state, and local policies affect sustainability, as well as how citizens, the private sector and communities influence the policy and governance processes” (p. 9). The focal point for this track does not specifically concentrate on studies within the economic, social, or environmental domains. The legislative and governance concentration is similar to a political science or public administration major. However, the Challenge Area requirements emphasize coursework in the environmental and social domains.
3. The International Development and Sustainability track “recognizes the interconnectedness between the social and natural systems” (p.9). This track includes coursework within all three sustainability domains.

4. The Sustainable Urban Dynamics track is focused on global sustainability’s dependence on the efficient planning, design, construction, management, and governance of urban regions. This track emphasizes urban planning and includes coursework on the environment and social domains of sustainability.

**Bachelor of Science in Sustainability**

According to the *Arizona State University School of Sustainability Undergraduate Handbook, 2011-2012* (2011):

The B.S. program introduces students to the concept of sustainability in the context of real-world problems, exploring the interaction of environmental, economic, and social systems. This degree is best suited to students inclined towards natural sciences, economics, and engineering. (p. 10).

The SOS provides students with the option of three different tracks within the BS degree in sustainability.

1. The Sustainable Energy, Materials, and Technology track “focuses on technological issues relevant to energy and materials including overall energy needs and impacts, current and future urban energy systems, thermodynamics, heat transfer and fluid mechanisms, atmospheric energy systems and field investigation” (p. 10).

Environmental issues and the economy are the domains relevant to this study track.
2. The Economics of Sustainability track “applies economic principles to the allocation of environmental goods and services” (p. 10). The sustainability disciplines of economics and the environment are the dominant themes of this track.

3. The Sustainable Ecosystems track “focuses on the environment ‘sphere’ of the 3-sphere sustainability model” (p. 10). This track emphasizes all three domains in the coursework of the program.

A review of the descriptions for the core and foundation courses at ASU indicated the dominance of the environmental and social disciplines. Environmental studies were mentioned in all the course descriptions with the exception of a course on general engineering principles in sustainability. Based on the course descriptions, economic studies played the smallest role in the curriculum. However, it is important to note that elective courses within a student’s field of study could cover potential disciplinary deficiencies within this program.

Portland State University

Portland State University offers two options with a concentration in sustainability for students enrolled in graduate degree programs at the university. The first option is a graduate certificate in sustainability administered through the Institute for Sustainable Solutions (‘Graduate Certificate’, 2012). The second option is a specialization in Leadership for Sustainability Education offered through the Educational Leadership and Policy Department (‘Leadership for Sustainability Education Specialization’, 2012).

The graduate certificate in sustainability requires the completion of six linked classes with a minimum of 22 credit hours. The Institute for Sustainable Solutions’ (2012) catalog describes the certificate as follows:
The Graduate Certificate in Sustainability offers an integrated series of post-baccalaureate courses that comprise a multidisciplinary study of the environmental, social, and economic dimensions of sustainability. Students will gain an understanding of the major theories and concepts related to the key dimensions of sustainability, as well as case analysis experience with applications to private and public projects. (“Graduate Certificate”, para. 1).

The graduate certificate is a two-part interdisciplinary program dedicated to building an understanding of sustainability in practice. The first part of the program creates a foundation of knowledge with a set of four core courses that examine the breadth of contemporary sustainability concepts and provides the opportunity for students to interact and share perspectives from their respective disciplines. The second part of the program allows the students to specialize within their respective field of study with a set of two elective courses of six to eight credit hours.

A review of the descriptions for the 15-credit core courses showed an equal distribution of disciplines in the economic, environmental, and social domains of sustainability (LSE Course Descriptions, 2012). The remaining elective courses showed an emphasis in the environmental disciplines with smaller concentrations in social and economic studies. However, this program provides the opportunity for graduate students to expand their field of study into other disciplines of interest.

The second option is a specialization in Leadership for Sustainability Education (LSE) offered within the Educational Leadership and Policy Department (ELP). This specialization requires 16 credit hours in the professional studies core, 8 credits in the LSE foundation courses, 12 credits in LSE Thematic Specialization courses, 5 credits of electives,
and a comprehensive exam or thesis (LSE Program of Study, 2012). These hours must be accompanied by the coursework for the Master of Science or Master of Arts in Education degrees.

The following 24 credit courses comprise the professional studies core (16 credits) and the required foundation courses (8 credits). A description of the required courses for this specialty is located in Appendix I.

- **ELP 511**: Principles of Educational Research and Data Analysis (core)
- **ELP 520**: Developmental Perspectives on Adult Learning (core)
- **ELP 568**: Educational Organization and Administration (core)
- **ELP 551**: Social Foundations of Education **OR** ELP 554: Philosophy of Education (core)
- **ELP 550**: Advanced Leadership for Sustainability (foundation)
- **ELP 517**: Ecological and Cultural Foundations of Learning (foundation)

A review of the descriptions for the core and foundation courses indicated that ELP 511, 520, and 568 were general education courses on research, epistemology, and organizational theory respectively (LSE Course Descriptions, 2012). The remaining courses showed an emphasis in the environmental and social domains of sustainability, with economic studies mentioned only in the advanced leadership course, ELP 550. This latter course also included discussions of the environmental and social domains. However, it is important to note that this program is for a specialization in sustainability and therefore provides the opportunity for inclusion of other course concentrations within the graduate student’s field of study.
A thorough discussion of these findings, conclusions, and implications on the transdisciplinary aspects conclusions is in Chapter 5 - Conclusions and Implications.

**Higher Order Skills**

**Instructor discourse**

The FTCB was the observational instrument used to determine and describe the cognitive levels of discourse for the Arizona State University and Portland State University courses. The instrument has been employed in similar comparison studies, one involving agriculture classes at Ohio State University (Ewing, 2006) and one involving pre-service education teachers at the University of Missouri (Ball & Garton, 2005).

A slight adaptation was required in this research study to match the categories of the comparison studies’ tabulated data. The FTCB was used to score instructor discourse levels for both the Ball and Garton (2005) study and the Ewing (2006) study, but the data for Ball and Garton were presented in terms of the original Bloom’s Taxonomy. Since the FTCB score sheet split Bloom’s Comprehension level into the translation and interpretation levels, the ASU and PSU data were re-categorized and adapted to fit Bloom’s model. To compensate for differences in the split, Bloom’s Comprehension level was checked only once in each segment when either Translation or Interpretation was checked during the six-minute period.

Table 6 shows the cognitive level of instructor discourse by course. Courses taught by Instructors 1 and 2 were observed during the fall term of 2011. The observations from the first course taught by Instructor 3 (listed as 3A) were conducted during the fall term of 2011. The second course was observed in the winter term of 2012. There were two observations conducted on the undergraduate course taught by Instructor 1 at ASU and four observations
conducted on the course taught by Instructor 2 at ASU. As mentioned earlier, Instructor 3 taught two different graduate courses at PSU with four observations conducted on the first graduate course at PSU and two observations conducted on the second graduate course.

As can be seen in Table 6, the total cognitive weighted score for instructor discourse ranged from 25.3, which indicated instruction occurring between the Comprehension and Application levels, to 31.4, which indicated instruction occurring between the Application and Analysis levels. It should also be noted that the weighted cognitive level of three courses was situated between Comprehension and Application, and only one of the graduate level courses was taught at cognitive levels above those of the undergraduate courses.

Table 6: Average percent of time for instructor discourse at cognitive level: ASU and PSU

<table>
<thead>
<tr>
<th>Bloom's Cognitive Level</th>
<th>Weighted Value</th>
<th>Instructor/Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.10</td>
<td>25.8</td>
</tr>
<tr>
<td>Comprehension</td>
<td>0.20</td>
<td>27.4</td>
</tr>
<tr>
<td>Application</td>
<td>0.30</td>
<td>16.1</td>
</tr>
<tr>
<td>Analysis</td>
<td>0.40</td>
<td>19.4</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.50</td>
<td>11.3</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.50</td>
<td>0.0</td>
</tr>
<tr>
<td>Total Cognitive Weight</td>
<td>26.3</td>
<td>25.3</td>
</tr>
</tbody>
</table>

An average of 50% of the classroom discourse for all instructors was taught at the lower order levels of learning, with 24% at the knowledge level and 26% at the Comprehension level. Conversely, the higher order levels of learning accounted for 50% with a distribution of 17% for Application, 17% for Analysis, 12% for Synthesis, and 4% for
Evaluation. Instructor 2 spent the largest percentage of time teaching in the lower order
cognitive levels of learning with an average of 56%. The observations for Instructor 2 were
conducted in one of the larger undergraduate classes with an average attendance of 42. The
least amount of time spent instructing at the lower levels of learning was 41%, which
occurred in the second graduate class observed. This class had an average attendance of 19
students during the two class observations.

Comparison studies

The fourth research objective was to analyze cognitive levels of behavior to
determine if significant differences existed between sustainability instructors and instructors
in other post-secondary fields of education. A significant number of studies have been
conducted on examining the cognitive levels of learning in education programs. Most of
these studies have performed analyses on education practices in university and high school
settings (Ewing, 2006; Ball & Garton, 2005; Whittington, Lopez, Schley, & Fisher, 2001;
Ulmer & Torres, 2001; and Pickford & Newcomb, 1989). The results from several studies
were compared to those of this study, although the sample sizes were too small to generalize
to the population of sustainability universities.

A study by Ball and Garton (2005) modeled higher order thinking and examined the
alignment of teacher discourse, assessments, and course objectives using the FTCB. The
data in Table 7 show the percentage of teacher discourse spent at each cognitive level for pre-
service teachers in undergraduate courses. The results found that lower orders of cognition
were modeled in 61% of classroom discourse. The Application, Analysis, Synthesis, and
Evaluation levels of cognition comprised 39% of the classroom discourse. These compare to
an equal split of 50% spent in lower order levels of classroom discourse and 50% spent in
higher levels of classroom discourse for sustainability teachers. The results of the independent t-test showed no significant difference between the lower order values of instructor discourse for the two groups of teachers ($p = 0.129$) nor between the higher order levels ($p = 0.206$).

Table 7: Average percent of instructor time at cognitive level: Ball and Garton

<table>
<thead>
<tr>
<th>Bloom's Cognitive Level</th>
<th>Weighted Value</th>
<th>Instructor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Mean %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>0.10</td>
<td>19.1</td>
<td>47.3</td>
<td>40.7</td>
<td>25.2</td>
<td>39.4</td>
<td>18.5</td>
<td>55.9</td>
<td>35.2</td>
<td></td>
</tr>
<tr>
<td>Comprehension</td>
<td>0.20</td>
<td>19.1</td>
<td>33.9</td>
<td>23.6</td>
<td>38.8</td>
<td>22.1</td>
<td>19.2</td>
<td>25.4</td>
<td>26.0</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>0.30</td>
<td>8.2</td>
<td>10.9</td>
<td>13.6</td>
<td>15.5</td>
<td>11.0</td>
<td>26.9</td>
<td>8.5</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td>Analysis</td>
<td>0.40</td>
<td>32.7</td>
<td>6.7</td>
<td>10.0</td>
<td>17.4</td>
<td>16.5</td>
<td>23.9</td>
<td>6.8</td>
<td>16.3</td>
<td></td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.50</td>
<td>13.6</td>
<td>0.0</td>
<td>7.9</td>
<td>2.9</td>
<td>5.5</td>
<td>11.5</td>
<td>1.7</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.50</td>
<td>7.3</td>
<td>1.2</td>
<td>4.3</td>
<td>0.0</td>
<td>5.5</td>
<td>0.0</td>
<td>1.7</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Total Cognitive Weight</td>
<td>31.7</td>
<td>18.1</td>
<td>22.9</td>
<td>23.4</td>
<td>23.8</td>
<td>29.1</td>
<td>17.6</td>
<td>23.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Adapted from Ball & Garton, (2005).

A study by Ewing (2006) involving 12 instructors in the College of Food, Agricultural, and Environmental Sciences (CFAES) at the Ohio State University (see Appendix J) found similar results to the Ball and Garton (2005) study. Ewing’s findings indicated that 62% of the instructor discourse was at the lower levels of Knowledge and Comprehension, with approximately 38% taught at the higher order levels of Application, Analysis, Synthesis, and Evaluation. The data in Ewing’s study were grouped by class session rather than by instructor, but the total cognitive scores for the study’s sample of 12
instructors ranged from a low of 14.47 (between knowledge and comprehension) to a high of 30.67 (the application level). The weighted cognitive mean for all class sessions was 25.6, indicating that instruction was taking place at the Interpretation level of learning. The total cognitive scores for the Ball and Garton sample ranged from 17.6 (between Knowledge and Comprehension) to a high of 31.7 (approximately at the Application level). The ASU and PSU study for sustainability teachers ranged from a low of 25.6 (between Comprehension and Application) to a high of 31.4 (approximately at the Application level).

The null hypothesis for research objective six posited that no significant difference existed between the weighted cognitive level of sustainability instructors and the weighted cognitive level of pre-service instructors (Ball & Garton, 2005). The statistical instrument for this analysis was the two-tailed independent t-test with significance set a priori at 0.05, which was used to compare the weighted cognitive levels of instructor discourse at each of Bloom’s levels.

The weighted values for each of the cognitive levels of Ball and Garton’s study are shown in Table 8 and the weighted values for this research study are in Table 9.
Table 8: Weighted cognitive level of instructor discourse Ball and Garton

<table>
<thead>
<tr>
<th>Bloom's Cognitive Level</th>
<th>Weighted Value</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Mean%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>0.10</td>
<td>1.9</td>
<td>4.7</td>
<td>4.1</td>
<td>2.5</td>
<td>3.9</td>
<td>1.9</td>
<td>5.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Comprehension</td>
<td>0.20</td>
<td>3.8</td>
<td>6.8</td>
<td>4.7</td>
<td>7.8</td>
<td>4.4</td>
<td>3.8</td>
<td>5.1</td>
<td>5.2</td>
</tr>
<tr>
<td>Application</td>
<td>0.30</td>
<td>2.5</td>
<td>3.3</td>
<td>4.1</td>
<td>4.7</td>
<td>3.3</td>
<td>8.1</td>
<td>2.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Analysis</td>
<td>0.40</td>
<td>13.1</td>
<td>2.7</td>
<td>4.0</td>
<td>7.0</td>
<td>6.6</td>
<td>9.6</td>
<td>2.7</td>
<td>6.5</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.50</td>
<td>6.8</td>
<td>0.0</td>
<td>4.0</td>
<td>1.5</td>
<td>2.8</td>
<td>5.8</td>
<td>0.9</td>
<td>3.1</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.50</td>
<td>3.7</td>
<td>0.6</td>
<td>2.2</td>
<td>0.0</td>
<td>2.8</td>
<td>0.0</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Total Cognitive Weight</td>
<td>31.7</td>
<td>18.1</td>
<td>22.9</td>
<td>23.4</td>
<td>23.8</td>
<td>29.1</td>
<td>17.6</td>
<td>23.8</td>
<td></td>
</tr>
</tbody>
</table>

The cognitive behaviors observed for the instructors at each of the six levels of Bloom’s Taxonomy revealed no significant difference ($p > .05$) between the two studies.

The $t$-values for the lower order levels of learning (Knowledge and Comprehension) were
1.89 ($p = 0.095$) and -0.73 ($p = 0.943$) respectively. The $t$-values at the higher order levels of learning were -0.919 ($p = 0.382$) for Application; -0.179 ($p = 0.862$) for Analysis; -2.106 ($p = 0.64$) for Synthesis; and -0.561 ($p = 0.588$) for Evaluation.

Table 10: Comparison of cognitive weighted scores for instructor discourse

<table>
<thead>
<tr>
<th>Cognitive Level</th>
<th>Pre-Service Instructors</th>
<th>Sustainability Instructors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Knowledge</td>
<td>3.52</td>
<td>1.45</td>
</tr>
<tr>
<td>Comprehension</td>
<td>5.20</td>
<td>1.51</td>
</tr>
<tr>
<td>Application</td>
<td>4.05</td>
<td>1.94</td>
</tr>
<tr>
<td>Analysis</td>
<td>6.51</td>
<td>3.83</td>
</tr>
<tr>
<td>Synthesis</td>
<td>3.08</td>
<td>2.55</td>
</tr>
<tr>
<td>Evaluation</td>
<td>1.43</td>
<td>1.43</td>
</tr>
<tr>
<td>Lower order$^2$</td>
<td>4.36</td>
<td>1.67</td>
</tr>
<tr>
<td>Higher order$^3$</td>
<td>3.77</td>
<td>3.08</td>
</tr>
</tbody>
</table>

$^1$ Data from Ball and Garton (2005).
$^2$ Consists of Knowledge and Comprehension levels.
$^3$ Consists of Application, Analysis, Synthesis, and Evaluation levels.

As shown in Table 10, the pre-service instructors from the Ball and Garton (2005) study had a lower order cognitive weighted mean of 4.36 (SD = 1.67) and the sustainability instructors had a cognitive weighted mean of 3.59 (SD = 1.61). The $t$-value for lower order thinking was 1.056 ($p = 0.304$). The higher order weighted mean for pre-service teachers was 3.77 (SD = 3.08). Sustainability teachers had a cognitive weighted mean of 5.42 (SD = 3.20) in the higher order levels of cognition. The $t$-value for the higher-order cognitive weighted scores for the comparison was -1.684 ($p = 0.100$). This comparison showed no
significant differences for $p > .05$ in either the lower or higher-order cognitive levels. The null hypothesis was accepted.

**Classroom Characteristics**

The data collection of classroom characteristics was obtained through qualitative measures during an embedded study. The data included the number of students, student-to-teacher ratios, gender diversity of the class, peer-to-peer interactions and student-to-instructor interactions.

Teachers have the opportunity to enact strategies outside of verbal discourse that can encourage critical thinking during class sessions. Positive feedback to student ideas, the level and amount of cognitive participation by the student, and the interaction among students within the same course all contribute to gains in critical thinking (Smith 1977). However, the characteristics of the classroom can either enhance or discourage the implementation of these strategies. One of the emerging themes that developed during the 16 hours of classroom observations for this project was the relationship between student engagement and class size. According to data collected by Tsui (2002), there is a higher incidence of classroom discussion when the average class size is approximately 20 students or less, and class size is a differentiating factor in class participation. Class size for the four courses studied ranged from a low of 19 students to a high of 60 students in the class. From observations of these courses, the average number of questions presented by the instructors also tended to be higher in the smaller classes.

Instructor 1 taught an undergraduate course with an average attendance of 54 students during the two classroom observations, including an average of 8 female students. There were no student assistants (SAs) in the class. During the class discussions and discourse
there were 15 exchanges by students during the first class and 12 exchanges during the second class. Two students made multiple comments and five of the responses in each of the two classes were prompted by questions from the instructor. The instructor’s responses to these comments and questions were met with positive reaffirmation of the students’ thoughts, answers to the students’ questions, and insightful critiques.

The second undergraduate course with Instructor 2 had an average attendance of 41 students (with an average of 23 female students) over the four sessions observed. Instructor 2 taught with two student assistants who aided the administration of the class materials, with one SA participating in the teaching in one of the classes. There was an average of 21 interactions (comments or questions) exchanged between the instructor and the students. The responses from the instructors to these comments were positive reaffirmations of the students’ thoughts, answers to direct questions, and insightful critiques. During the last session, one of the student assistants did a presentation on her dissertation’s data collection, analysis, and results. This class had the highest number of participants with 27 student encounters. The exchanges were often the result of questions from the instructor or the SA in an attempt to generate participation, although there were several occasions when these questions resulted in no responses from the students.

The graduate courses for Instructor 3 were observed during three visits, two conducted for the first course and one for the second course. The average attendance and participation for the first course was 21 students (14 females), with 38 exchanges with the instructor. The second course had an attendance of 19 students with 61 exchanges between the instructor and students. In all three classes attended, every student interacted with the instructor at least once during each class. The responses to these comments were met with a
positive reaffirmation of the students’ thoughts, insightful critiques, or a probing question. These engagements included updates on group projects performed outside of class, small group discussions and presentations, questions from the readings, and a major term project involving the Learning Garden Laboratory. Questions and comments on classroom discourse were also observed, but lectures (including slide presentations) were minimal during all three sessions.

The courses for Instructor 3 also had extensive peer-to-peer discussions while working on group projects. These activities consisted of group projects in the form of role-playing, discussion on assignments that were presented in class, and an outside service project. As an example, during one session, students formed five groups to discuss the concepts of sustainability covered in several textbooks used for class. The findings were then presented to the class through role-playing. Observing the total number of peer-to-peer exchanges with each of five groups was not practical for the researcher, but student involvement was recorded to highlight full participation by all members of the group. In all cases, every student within the groups provided salient input during the group discussion and in the role-playing aspects of the presentation.

Class sizes for the graduate courses were considerably smaller than those of the undergraduate courses. The average attendance for each of the two graduate courses taught by Instructor 3 was 20 for the first course and 19 for the second course. Females comprised the majority of the two courses with an average of 14 females in the first course and 15 females in the second. The degree of interactivity between the instructor and the students as well as peer-to-peer (student interaction with other students) was much higher than those in the undergraduate classes taught by Instructors 1 and 2.
Instructor strategies

The sixth research objective was to describe instructor strategies that encourage higher order thinking skills. Studies have shown a positive correlation between critical thinking and the following strategies:

- Having a paper critiqued
- Conducting independent research
- Giving a class presentation
- Essay exams in lieu of multiple choice tests;
- Service learning projects; and
- Group work within a class (Astin, 1993).

Group projects build on peer-to-peer relationships and engage students in critical thinking activities (Astin 1993). Cooperative learning experiences such as service learning projects can also contribute to enhanced leadership abilities, public speaking skills, the ability to influence others, and the ability to work in teams (Pascarella & Terenzini, 2005).

The graduate courses at Portland State University made use of this pedagogy extensively. Small group projects were used in every class and in some cases multiple times, during both courses. These exercises involved peer-to-peer activities including role-playing, developing leadership techniques, and presentations. The cognitive levels of learning focused on during these assessment exercises included Application, Analysis, Synthesis, and Evaluation.

One of the more extensive assignments in the first graduate course that was observed involved the Learning Garden Laboratory. The garden was established in 2005 as a partnership between PSU, Portland Public Schools, Portland Parks and Recreation, and the
Oregon State University Extension Service (‘Learning Garden’, 2012). This facility is a 12-acre garden education site located at 6801 SE 60th Ave in southeast Portland. It is a service project to the community that “provides K-12, university students and community members hands-on and place-based education in sustainable gardening, healthy nutrition, and permaculture” (‘Learning Garden’, para. 1). The garden is a community-based education facility that helps students develop leadership skills while providing an example of a sustainable local food system for the community. As a term project for the class, the graduate students developed a marketing plan that included a website and community outreach strategies. During one class session, the instructor turned the leadership over to the students who were empowered to manage the project. Without input from the teacher, the group developed a work plan and discussed the methodology, schedule, progress, and responsibilities of the members.

The second class at PSU also included assessments associated with positive learning outcomes. A small group project required students to employ reflective thinking to self-analyze their respective strengths and styles of teaching. The end product of this exercise was a class presentation directed at teaching new concepts of best practices in sustainable development. Other pedagogical methods employed during the course that emphasized critical thinking skills included essay assignments, independent research, and role-playing.

One of the instructors at ASU mentioned the difficulty of managing large classes in regard to developing group projects and engaging students in discussions. One of the methods used to increase participation was to include variety in the discourse or, as the instructor put it, to “mix it up” with digital media, case studies, and questions to the students (personal interview 11/14/2011). One of the critical points mentioned was to “make the
students feel comfortable” about making comments, raising questions or challenging the instructor. This technique was mentioned by Tsui (2001) as a positive method of encouraging critical thinking skills. The general consensus of the instructors was that smaller classes were more adaptable to alternative methods of instruction.

The course taught by Instructor 1 at Arizona State University employed presentations, small group discussions, essays, and primary research as assessment methods. As noted previously, all of these pedagogical tools encourage higher order learning outcomes. The large size of this undergraduate class would have made small discussion groups impractical; however, the instructor used the course’s Tuesday sessions for lectures and the Thursday sessions for small group work. The teaching assistant facilitated the Thursday groups, which discussed the topics presented during the first class of the week. Grades for this section consisted of class participation, weekly writing assignments, and a term paper.

The course taught by Instructor 2 at Arizona State University also utilized essays involving primary research, as well as a group project involving a sustainability issue in the Phoenix area. The outcome of the latter project was a presentation on the project’s goals and outcomes and a poster session similar to those used at conferences. The only assessment method from the three classes that was negatively associated with developing higher order thinking skills was an exam that included multiple choice and true false questions. However, the exam included essays as part of the assessment as well.

All three instructors were deeply involved in the sustainability field and have published numerous articles on sustainability-related education. Two of the instructors have written papers on the reorientation and transformation of sustainability education, which incorporates many of the same concepts that encourage higher order thinking skills. One of
the points discussed during interviews with the instructors was the importance of these
assessment tools. All three instructors were aware of the benefit of implementing these
measures and other active learning concepts into the realm of sustainability education.

The quantitative aspect of this research objective examined the cognitive levels of the
assessments outlined in each syllabus. As shown in Table 11, there was no entry for
Instructor 2. Assessments for this instructor included 65% of the course objectives written at
the Evaluation level; however, the remaining 35% consisted of an exam with a combination
of assessment methods, which was not made available for this research study. Subsequently,
the assessments for this instructor were not evaluated.

The percent of assessments dedicated to lower order levels of cognition for the three
courses analyzed was 22%, with the remaining 78% occurring in the higher order levels.
Assessments were spread over all six levels for Instructor 1 with 72% of the assessments at
the Application and Analysis levels and only 10% at the Synthesis and Evaluation levels.
The first class assessed for Instructor 3 showed a concentration of 41% occurring at the
Analysis level, with a total of 65% when combined with the Application level. Instructor 3’s
first class had no assessments at the Synthesis level, but had the highest total for Evaluation
of all classes at 15%. The second course for Instructor 3 was distributed similarly, with 61%
of the assessments focused on the Application and Analysis levels of cognition. The
cognitive levels dedicated to Synthesis and Evaluation represented 8.3% and 9.2% respectively for Instructor 3’s second course.
Table 11: Cognitive level of assessments

<table>
<thead>
<tr>
<th>Bloom's Cognitive Level</th>
<th>Weighted Value</th>
<th>1</th>
<th>2</th>
<th>3A</th>
<th>3B</th>
<th>Mean%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>0.1</td>
<td>15</td>
<td>x</td>
<td>14</td>
<td>12.5</td>
<td>13.8</td>
</tr>
<tr>
<td>Comprehension</td>
<td>0.2</td>
<td>2.5</td>
<td>x</td>
<td>6.5</td>
<td>14</td>
<td>7.7</td>
</tr>
<tr>
<td>Application</td>
<td>0.3</td>
<td>35</td>
<td>x</td>
<td>24</td>
<td>14</td>
<td>24.3</td>
</tr>
<tr>
<td>Analysis</td>
<td>0.4</td>
<td>37.5</td>
<td>x</td>
<td>40.5</td>
<td>32</td>
<td>36.7</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.5</td>
<td>5</td>
<td>x</td>
<td>0</td>
<td>20</td>
<td>8.3</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.5</td>
<td>5</td>
<td>x</td>
<td>15</td>
<td>7.5</td>
<td>9.2</td>
</tr>
<tr>
<td><strong>Cognitive Weight</strong></td>
<td><strong>33.3</strong></td>
<td><strong>x</strong></td>
<td><strong>33.6</strong></td>
<td><strong>36.9</strong></td>
<td><strong>34.6</strong></td>
<td></td>
</tr>
</tbody>
</table>

The total cognitive weights for Instructors/Classes 1, 3A, and 3B were 33.3, 33.6, and 36.9 respectively. This indicates assessments concentrated between the application and analysis levels of cognition. The mean for the three courses was 34.6, which indicates cognitive levels of assessment concentrated between the same two levels of learning.

**Course objectives**

Course objectives reflect the intended learning outcomes and serve as a guide to the instructional process. Research objective seven was to describe the course objectives for the sustainability courses at ASU-PSU and to describe the alignment of the objectives, assessments and instructor discourse. The analysis for this objective applied both qualitative and quantitative methods.

The qualitative analysis was achieved through observational notes taken during the classes to determine if the instructors’ discourse during these sessions matched the course
objectives and assessments outlined in the syllabus. As expected, there were minor deviations in the subject matter discussed; however with the exception of one case, the topics presented in the class schedules were aligned with the instructor discourse. The instructors’ discourse and schedules were also aligned with the course objectives and assignments. One of the class syllabi did not contain a class schedule and could not be tracked for content, but the subject matter discussed during class did match the assessments and course objectives.

As noted in Table 12, only 6% of the course objectives were written for outcomes at the knowledge level of cognition, which accounted for the smallest percentage. The largest percentage of objectives was 27%, and these were written at the application level of cognition.

**Table 12: Cognitive level of course objectives**

<table>
<thead>
<tr>
<th>Bloom's Cognitive Level</th>
<th>Weighted Value</th>
<th>Instructor/Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>0.10</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M%</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.10</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6%</td>
</tr>
<tr>
<td>Comprehension</td>
<td>0.20</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19%</td>
</tr>
<tr>
<td>Application</td>
<td>0.30</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22.2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27%</td>
</tr>
<tr>
<td>Analysis</td>
<td>0.40</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14%</td>
</tr>
<tr>
<td>Synthesis</td>
<td>0.50</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Evaluation</td>
<td>0.50</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
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<td>0.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15%</td>
</tr>
<tr>
<td>Total Cognitive Weight</td>
<td>30.0</td>
<td>40.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>34.3</td>
</tr>
</tbody>
</table>

Approximately 25% of the course objectives were comprised of the lower order levels of learning, Knowledge and Comprehension. The remaining 75% of objectives that written at the higher levels of Bloom’s taxonomy were distributed among Application, Analysis,
Synthesis, and Evaluation at 27%, 14%, 20% and 15%, respectively. The range of course objectives dedicated to higher order learning ranged from 67% to 80%.

The course objectives for Instructor 1 were concentrated between the Comprehension and Synthesis levels, with the largest percentage devoted to Application outcomes. The total cognitive weight for this teacher’s objectives was 30, which represents learning outcomes focused at the Application level. Instructor 2 had no objectives at the Knowledge, Analysis, or Synthesis level and was the only instructor with 60% of the written objectives centered at the Evaluation level. Comprehension and Application accounted for the remaining 40% of the intended goals for the course at 20% each. The cognitive objectives written for Instructor 2’s course had the highest total cognitive weight of 40, which represents objectives concentrated at the Analysis level.

Instructor 3 taught the two graduate classes and had the highest concentration of course objectives at the Knowledge and Comprehension level representing 23% in the first class and 25% in the second class. The remaining percentages for the first course were 22%, 11%, and 33% for Application, Analysis, and Synthesis respectively and an even distribution of 25% each for Application, Analysis, and Synthesis for the second course. The course objectives written for Instructor 3’s courses both had total cognitive weighted scores of 33, indicating that overall intended learning outcomes were between the Application and Analysis levels of learning.
CHAPTER 5 - CONCLUSIONS AND IMPLICATIONS

This chapter provides a summary of the problem and an overview of the study including the limitations, recommendations, and opportunities for future research.

Introduction

The ultimate goal of sustainability education is not to create a knowledgeable society, but to impart the necessary wisdom to create a sustainable society. This requires a transformation of teaching methods in higher education that incorporate new teaching and learning methods. The traditional linear process of education discussed by Cook et al., (2010) has characteristically been “based on subject divides” (p. 317) and has not been sufficient to educate the public and stem the deterioration of the environment. The complex environmental, economic, and societal systems require strategies that employ higher order levels of instruction aligned with challenging assessments the sum of which stretch across disciplinary boundaries.

The complexity of the socio-economic-ecological challenges require “multi-faceted and interdisciplinary approaches” (Jones et al., 2010, p. 31) for higher education courses and programs. Transdisciplinary studies are present in both the ASU programs and the PSU programs that were examined. The required core courses were balanced in regard to the sustainability domains of economic, environmental, and societal courses. The elective courses trended toward environmental sciences more heavily in both programs but still offered course options in the economic and social domains. This emphasis is logical in these institutions since environmental scientists and engineers have taken the lead in addressing sustainability strategies and had a significant part in developing education resources (Chalkley et al., 2010).
The cognitive levels of instruction were derived from courses selected from the core curriculum at each university. The instructors’ discourse, course objectives, and assignments were evaluated in reference to their cognitive levels of instruction. Three classes were recorded and re-evaluated three weeks after the class to validate the accuracy of the data collection procedures of the sole researcher. The results of this analysis were derived from the Pearson Product-Moment Coefficient. The average reliability for the three tapes reviewed by the sole researcher for this research study was $r = 0.97$.

The courses and programs at Arizona State University and Portland State University indicated a trend toward transformative education in regard to cognitive learning skills. Higher order cognitive instruction was evident in all the classes studied, however no statistically significant differences were found in comparison studies.

Instructor strategies that were positively associated with developing higher levels of cognition were present in all four classes in the form of in-class assessments, community service projects and assignments. The only assessment negatively associated with growth in higher order thinking was a combination exam which included multiple choice and true false questions.

Transdisciplinary studies and pedagogical approaches that develop higher order cognitive thought processes and skills are the cornerstones for building effective university programs in sustainability education. However, transforming traditional educational practices will also require dedicated professors with the knowledge and skills to teach, mentor, and create tools for students to connect, analyze, and resolve complex environmental problems. The beneficiaries of these new sustainability programs will include the administrators, professors, and students at the universities being studied, and this study may
encourage similar analyses and adaptations by other colleges with sustainable education programs.

**Summary**

The demographics for the three instructors who participated in this study included two women (67%) and one man (33%) teaching two undergraduate courses at Arizona State University (ASU) and two graduate courses at Portland State University (PSU). Two of the teachers in the sample were assistant professors, one was a full professor, and all had earned their doctorate degrees. Two of the three instructors (one man and one woman) taught undergraduate classes for the Arizona State University Global Institute of Sustainability and one of the female instructors taught the two graduate certificate courses at the Portland State University program for the Institute of Sustainable Solutions. Educational experience at post-secondary schools ranged from 12 to 15 years, with approximately half of that time dedicated to sustainability education for each instructor.

According to Thomas (2007), teachers “need to build a community in which students experience their passion” (p. 63). This bonds the students and instructors which provides a foundation for better learning. Sustainability appears to exemplify the lifestyles of the instructors who taught the courses evaluated in this study. This passion is reflected in their educational practices and provides a better learning experience for students who sense their enjoyment in teaching. Although sustainability education is a relatively new program area in academic settings, each instructor had between six and eight years of experience teaching in that field. Interviews with each of the instructors indicated their dedication to teaching sustainability courses and their commitment to sustainable practices, evidenced by multiple publications on topics including redesigning and transforming sustainability education.
The transformation or reorientation of sustainability education encompassed two dominant themes in the literature: the thematic scheme of transdisciplinary education (Burns, 2011) and a redirection toward higher order thought processes (Stracham, 2009). The Global Institute of Sustainability at Arizona State University and the Institute for Sustainable Solutions at Portland State University both offer a diverse suite of courses in sustainability.

ASU’s School of Sustainability (SOS) offers students two degrees, a Bachelor of Arts or a Bachelor of Science in Sustainability. Graduation requirements for each degree include two prerequisite classes, 15 hours within the core curriculum or Challenge Area Courses, and elective courses within a track of the student’s choice. A review of the descriptions for the core and foundation courses at ASU indicated a concentration in the environmental and social disciplines, with economic studies offered in fewer courses based on the course descriptions. However, it is important to note that elective courses within a student’s field of study could address potential disciplinary deficiencies within these courses.

Portland State University offers the option of a graduate certificate in sustainability through the Institute for Sustainable Solutions or a specialization in Leadership for Sustainability Education. The findings for the 15-credits of core courses for the certificate showed an equal distribution of transdisciplinary studies with 33% in the economic, environmental, and social domains of sustainability respectively. The remaining elective courses showed an emphasis in the environmental disciplines (56%) with smaller concentrations in social (18%) and economic studies (26%). This excluded the technical and instructional classes that provided general education focused on such fields as environmental sciences and engineering.
The core courses for the specialization in Leadership for Sustainability Education (LSE) favored the environmental and social domain with approximately 45% of the focus on these two domains and only 10% centered on the economic domain. As with ASU, both the graduate certificate and the specialization options offer students the opportunity to gain transdisciplinary knowledge of other subject fields through the respective students’ majors.

Several articles in the literature highlighted the importance of balancing course offerings and credits across the domains of sustainability (Davis, 2001). The core courses for the respective degrees and certificates of the two institutes studied are comprised of offerings within the domains of economic, environmental, and social disciplines of sustainability. However, environmental courses tend to dominate the approved electives with fewer offerings in economics or business-related courses and social responsibility.

The barriers to providing transdisciplinary studies are evident in the body of literature as well. Instructors may be reluctant to teach in fields they are unfamiliar with (Moore, 2005b; Giddens, 1995), and the pressure to publish articles in an effort to gain tenure may dampen an instructor’s commitment to change (Cortese, 2003). In addition, the call for transdisciplinary studies in the post-secondary curriculum leaves the pragmatic aspects of quantifying the number of credits in each domain up to the administration of each academic institution. The absence of a minimum number of credit hours for courses within disciplines other than environmental sciences may be problematic if a program endorses courses within specific disciplines (Dale & Newman, 2005; Davis, 2001).

The FTCB was the quantitative instrument used to measure and determine the cognitive level of in-class discourse by the instructors in the sample (research objective three). Studies involving agriculture classes at Ohio State University (Ewing, 2006) and pre-
service education teachers at the University of Missouri (Ball & Garton, 2005) were compared to sustainability instructors at ASU and PSU. Although the studies showed no significant increase in any of the levels of cognitive instruction during discourse, sustainability instructors did spend more time teaching in the higher order levels than did instructors in the comparison studies.

The findings indicated that sustainability instructors’ discourse was conducted at the lower order level of cognition approximately half of the time. The Knowledge level represented an average of 24% of class time and the Comprehension level represented 26% while the higher order levels of cognitive learning conveyed through instructor discourse accounted for 50% with a distribution of 17% for Application, 17% for Analysis, 12% for Synthesis, and 4% for Evaluation. Instructor 3, who taught the second graduate course with an average attendance of 19 students, spent the most amount of time (approximately 59%) instructing at the higher order levels.

By comparison, pre-service teachers were modeled in 61% of classroom discourse at the lower orders of cognition (Ball & Garton, 2005). The higher order levels of Application, Analysis, Synthesis, and Evaluation levels of cognition comprised 39% of classroom discourse for this group. Findings in Ewing (2006) were similar to those of Ball and Garton in percentage of time spent at the lower and higher order levels of cognition. The results for the study of university agriculture teachers indicated that 62% of the instructor discourse was at the lower levels of Knowledge and Comprehension with approximately 38% taught at the higher order levels of Application, Analysis, Synthesis, and Evaluation. An independent t-test comparing pre-service teachers with the sustainability teachers showed no significant difference between the lower order values of instructor discourse for the two groups of
teachers ($p = 0.129$) nor between the higher order levels ($p = 0.206$). Independent $t$-tests were not conducted on the Ewing study.

A $t$-test comparison of instructors’ discourse at each of the six levels of Bloom’s Taxonomy also revealed no significant differences ($p > .05$) between the pre-service teachers and sustainability teachers based on level of cognition. The $t$-values for the two lower order levels of learning, Knowledge and Comprehension, were 1.89 ($p = 0.095$) and -0.73 ($p = 0.943$) respectively. The $t$-values at each of the four higher order levels of learning were 0.919 ($p = 0.382$) for Application; -0.179 ($p = 0.862$) for Analysis; -2.106 ($p = 0.64$) for Synthesis; and -0.561 ($p = 0.588$) for Evaluation.

The results from the comparison of pre-service instructors (Ball & Garton, 2005) and sustainability instructors indicated no statistically significant differences between the mean cognitive weighted scores of instructor discourse at any of the six levels ($p = 0.05$): therefore, the null hypothesis was supported. The size of each of the comparison samples was too small to draw conclusions about the larger population, which may have contributed to these findings. The standard deviations for the pre-service teachers were much larger than those of the sustainability teachers, indicating more variance in the sample. Further research in this area is warranted, with larger samples and random sampling methods to improve the validity and accuracy of these calculations.

Managing complex systems requires critical thinking skills to ensure that students possess the capabilities to make responsible and prudent decisions (Parker, 2010). If graduating students are to think at the higher cognitive levels, professors must provide discourse and instructional strategies at levels that will challenge students.
Research supports the need to transform sustainability education to provide solutions for the complex issues associated with sustainable development (Sherren, 2006; Warburton, 2005; Parker, 2010). Providing the pedagogical methods that encourage the development of higher order thinking skills is considered to be a critical part of this process. Instructor discourse must be designed to incorporate higher cognitive instruction during classes, coupled with course objectives and assessments that are aligned with this goal. Each aspect of the classroom, from the initial instructor discourse to the final exam, advances the opportunity for students to acquire interdisciplinary knowledge and develop critical thinking skills. Characteristics of the classroom (research objective five) and instructor strategies for education (research objective six) can have a significant influence on the scale and effectiveness of learning outcomes for the student.

Smith (1977) found that positive interactions between the student and faculty, the frequency and cognitive level of participation by the student, and the peer-to-peer interactions among students in a course, were consistently and positively related to higher level of critical thinking skills (Tsui, 2002). One of the themes that emerged during the 16 hours of classroom observations was the relationship between these types of student engagement and class size.

The average attendance for classes was 54 students (Instructor 1), 41 students (Instructor 2), 21 students (Instructor 3-first course), and 19 students (Instructor 3-second course). Student exchanges with faculty for the larger classes ranged from 12 in one class to 27 in the last class observed. Student interaction for the smaller graduate courses ranged from 38 exchanges to 61 exchanges between the instructor and students. In all four classes attended, every student interacted with the instructor at least once during each class.
The exchanges from the larger undergraduate classes were most often the result of questions from the instructor directed to students or from the students to the professors. Faculty responses to questions and comments were positive; affirming each student’s thoughts, answering the student’s questions or offering insightful critiques. It should be noted that the second class of each week in one of the undergraduate courses was dedicated to small group discussions. These classes were not observed by the researcher, however.

The exchanges during the smaller graduate courses were interactive and engaging, often including updates on group projects performed outside of class, small group discussions and presentations, questions from the readings, and a major term project involving Portland’s Learning Garden Laboratory. These courses had extensive peer-to-peer discussions while working on group projects in the form of role playing, discussion on assignments that were presented in class, and an outside service project. Questions and comments on classroom discourse were also observed: however, lectures (including slide presentations) were minimal during all class sessions.

Education is a process comprised of multiple options and applications for instruction and learning. A qualitative analysis was used to determine the presence of the pedagogical strategies that have a positive association with developing higher order cognitive processes (research objective six). Studies by Astin (1993), Tsui (2001; 2000; 1999) and Moore (2005b) concluded that students’ critical thinking skills could be enhanced by having a paper critiqued by an instructor, conducting independent research, working on a group project, giving a class presentation, and taking essay exams. Cooperative learning (Pascarella & Terenzini, 2005), experiential learning, and active learning (Burns, 2011; Springett, 2010;
Allen-Gil et al., 2008) were also found to contribute to students’ self-assessed growth in critical thinking.

The findings indicated that the sustainability classes observed at Arizona State University and Portland State University utilized in-class strategies and assessments that positively reflected the development of higher order cognitive thinking skills. Small group projects were routinely conducted in one of the ASU undergraduate courses and in both PSU graduate courses. In the graduate courses, these exercises involved peer-to-peer activities such as role playing, developing leadership techniques, and presentations. Cognitive instruction during these assessment exercises was concentrated on the Application, Analysis, Synthesis, and Evaluation levels of learning.

Data on assignments were obtained from the syllabus for each course and also reflected a trend toward developing critical thinking. The core exercises (those not including credit for class attendance) involved essay assignments, primary research, small group work, and experiential/cooperative group projects. The latter assignments involved transdisciplinary sustainability projects in Phoenix and Portland. These projects encouraged higher order cognitive learning through primary research, active learning, community involvement, and peer-to-peer engagement of the students. The only assessment method from the classes that was negatively associated with developing higher order thinking skills was an exam that included multiple choice and true/false questions.

Data support a higher degree of class participation where the average class size is smaller (Tsui, 2002), which appeared to be a differentiating factor in this sample. The two courses with fewer students showed greater participation in both student-to-teacher engagement and peer-to-peer interaction. Student engagement with faculty and with other
students is positively associated with self-assessed growth in critical thinking skills (Astin 1993). Observations and interviews with the faculty also indicated that larger classes also pose a challenge to group work, an instructional method that is also positively associated with growth in critical thinking skills. There was no observable evidence that the student-to-teacher ratios increased or decreased the number of questions from the students.

Smaller classes encourage greater interaction between faculty and students, which encourages the development of higher order cognitive learning skills. However, smaller classes may be difficult to implement in undergraduate courses. The current structure of the two universities studied and possibly for most traditional programs, is to group freshman and sophomore classes in large classrooms. Financial considerations on the part of the administration may be a part of this decision process; however, since many of these are required classes for a variety of majors, the sheer number of students enrolled warrant lecture hall seating to accommodate volume of students.

Group projects enhance the opportunity to engage in peer-to-peer interactions and smaller classes increase the potential to conduct group projects. In light of these results, smaller classes may increase the opportunity to develop higher cognitive learning skills.

Creating an engaged interactive community based program for students is one method for refocusing sustainability education to meet the needs of society (Jones et al., 2010; Springett, 2010; Nicolescu, 1997). Part of this metamorphosis includes adapting the assessment methods and other instructor strategies employed at higher education institutions.

Instructor discourse is only one example of instructional strategies that can contribute to higher order learning. Cognitive thinking skills are enhanced by having a paper critiqued by an instructor, conducting independent research, working on a group project, giving a class
presentation, and taking essay exams (Tsui, 2001; Astin 1993). Cooperative learning, experiential learning, and active learning have also been found to contribute to self-assessed growth in critical thinking (Burns, 2011; Springett, 2010; Allen-Gil et al., 2008; Pascarella & Terenzini, 2005). The four classes examined for this research project utilized a variety of these assessments through in-class assignments, homework, small group projects, and service learning projects.

Building a sustainability program requires that a variety of pedagogical tools be employed to create responsible, empowered, and productive citizens (Newman, 1999). Programs must adapt their learning processes continually and explore new paradigms of teaching. Community involvement will become more important as efforts are made to teach university students “real world” skills through experiential learning and active learning. Empowering students through group projects and presentations will encourage critical thinking skills and must also be employed both inside and outside of the classroom. As these changes are gradually introduced into the curriculum, traditional lectures may be replaced by less formal instructor discourse.

Course objectives act as a guide in both the instructional process and the assessment process (Linn et al., 2005). Quantitative analysis was used to determine the cognitive level of course objectives and assessments and to describe the alignment between the cognitive levels of discourse, objectives, and assessments. The alignment between assessments, course objectives and instructor discourse were analyzed using Bloom’s taxonomy (Bloom et al., 1956) and Bloom’s revised taxonomy (Anderson et al., 2001). Observational notes were taken during the classes and evaluated immediately after the classes against the respective professor’s discourse and the scheduled content for that evening. The material discussed
during the evening was also compared to the course objectives and assignments for alignment. Only one course did not contain a class schedule and subsequently could not be tracked against the content that was covered during that class. However, the content of instructor discourse was determined to be in alignment with the course objectives. As expected, there were minor deviations from the objectives in the subject matter discussed; however, the instructors’ discourse for all classes was aligned with the course objectives and assignments.

The percent of assessments dedicated to lower order levels of cognition for the courses analyzed was 22%, with the remaining 78% occurring in the higher order levels. Assessments covered all six levels for Instructor 1, with 72% of the assessments at the Application and Analysis levels and only 10% at the Synthesis and Evaluation levels. The first class assessed for Instructor 3 showed a concentration of 41% occurring at the Analysis level with a total of 65% when combined with the Application level. Instructor 3’s first class had no assessments at the Synthesis level, but had the highest total for Evaluation of all classes at 15%. The second course for Instructor 3 was distributed similarly, with 61% of the assessments focused on the Application and Analysis levels of cognition. The cognitive levels dedicated to Synthesis and Evaluation represented 8.3% and 9.2% respectively for Instructor 3’s second course. The total cognitive weights for Instructors/Classes 1, 3A, and 3B were 33.3, 33.6, and 36.9 respectively. This indicates assessments concentrated between the Application and Analysis levels of cognition. The mean for the three courses was 34.6, which indicates cognitive levels of assessment concentrated between the Application and Analysis level of learning.
The average distribution of course objectives for the sample indicated that the lower order levels of learning, Knowledge and Comprehension, comprised approximately 25% of the course objectives. The remaining 75% were written at the higher levels of Bloom’s taxonomy and distributed among Application, Analysis, Synthesis, and Evaluation at 27%, 14%, 20% and 15%, respectively. The largest percentage was 27% and was written at the Application level of cognition, and the range of course objectives dedicated to higher order learning for the four classes ranged from a low of 67% to a high of 80%.

The cognitive level of the course objectives for Instructor 1 was the lowest of the four classes at 30, which represents learning outcomes focused at the Application level. The cognitive objectives written for Instructor 2’s course had the highest total cognitive weight of 40, which represents objectives concentrated at the Analysis level. The course objectives written for Instructor 3’s courses had total cognitive weighted scores of 33 and 34, indicating overall intended learning outcomes for these objectives were between the Application and Analysis levels.

One of the recurring themes of the literature review was the need to create educational processes that enhance cognitive learning skills across the economic, environmental, and social domains of sustainability. Course objectives that provide a guide to the curriculum and assessments that measure the success of the outcomes should be reflective of the intent to develop higher order learning processes (Ball & Garton, 2005). In turn, instructor discourse should present the subject content and teach at the same levels associated with these instruments.

The qualitative analysis achieved through class observation showed only minor deviations from the subject matter that was taught through the respective instructors’
discourse in each class. The basic precepts for all classes were aligned with the course objectives and assignments. However, the cognitive levels of instructor discourse tended to be slightly lower than both the course objectives and assessments. The average weighted cognitive levels of learning were 35% for assessments, 34% for objectives, and 29% for instructor discourse.

The results imply that teachers are aligning course objectives and assessments with instructor discourse. Further implications indicate that all three of the analyses target the higher order levels of cognitive skills. However, course attributes are on average at the low end of the Application level, the lowest of the higher order cognitive thought processes.

**Limitations of the Study**

The sample size and representativeness of the population influences the accuracy of research studies (Thorkildsen, 2005). Since the sample size was small for this study and for the comparison studies, the findings are limited to the two schools that participated. Any comparisons or generalizations to other institutions should be drawn cautiously and only within the context of the participating universities. An additional limitation is that the samples of participants from each university were purposely selected based on availability of the professors and students as well as permission from the administration of each college. Therefore, the sample is not representative of the population.

The population for this study involved combining data from both undergraduate and graduate courses which could influence the results that were obtained. A stratified sample with a larger population may be appropriate in future studies.

Maxwell (2005) indicated that an observer’s presence in class may influence the typical classroom behavior of the subjects. In addition, the qualitative analysis performed as
part of this study may include bias from the researcher’s “theories, beliefs, and perceptual lens” (p. 108), which cannot be eliminated.

The sole researcher for this study collected data using the Florida Taxonomy of Cognitive Behavior. The only training the researcher received for this phase of the analysis was through conversations with those experienced in the field who had conducted numerous studies in the past. Although a confirmation of the reliability of the researcher was performed using video tapes, there was not a validity check of the data collection since there was only one researcher conducting the study.

**Recommendations**

**Transdisciplinary studies**

The complex nature of sustainability merits the implementation of transdisciplinary fields of study (Hadorn, Bradley, Pohl, Rist, & Wiesmann, 2006). The disciplines of economics, environmental sciences, and a profusion of social science courses in a variety of departments share the common goal of providing the means to create a sustainable future. However, the academic boundaries that separate these fields into departments often act as barriers. Impediments also exist due to the pressures to obtain grants and publish articles within professors’ respective fields of expertise rather than straying into lesser known territories (Warburton, 2003).

Removing these barriers is the responsibility of the administration in cooperation with faculty from different departments and colleges. One solution would incorporate an overall institutional commitment that integrates policy with a strategic plan that linking sustainability curriculum to the institution’s goals (Jones, 2011). Collaborative projects between departments create more time for reflection and can build a commonwealth of
interdisciplinary plans (Moore, 2005a). These projects can promote transdisciplinary teaching through discussions of epistemologies that integrate culture, economics, and environmental models. Academic consultants who possess the experience and expertise in the field of sustainability can also provide staff development opportunities across disciplines. These programs could be conducted during staff retreats, interdepartmental meetings, or in electronic forms such as webinars or electronic resource sites within an institution’s intranet.

**Cognitive levels of instruction**

Teachers should aspire to teach toward higher order cognitive skills to educate individuals and build communities capable of addressing the dynamics of interconnected systems (Kagan & Hahn, 2011; Cotton & Winter, 2010; Warburton, 2003). This skill is critically important in sustainability education, where seemingly subtle changes in one domain can often have dramatic and adverse impacts on another. Professors must first realize the cognitive levels at which they are teaching and then take the necessary steps to increase those levels. These steps should involve strategies that encourage higher levels which may result in fewer lectures and more time dedicated to developing active learning environments for the students.

In studies of cognitive levels of learning, instructor discourse has been shown to be less productive in teaching at higher levels of learning than at lower levels (Ulmer & Torres, 2005; Ball & Garton, 2005; Miller & Pilcher, 2001). Reorienting higher education toward developing higher order thought processes can be achieved through in-class activities such as group projects, presentations, and activities that engage the students with faculty and peers. Sustainability education also thrives on assessments built around community projects and other activities that encourage group work in a cooperative environment. One of the classes
at Portland State University conducts ateliers (workshops involving real world problems). These assessments provide “hands-on problem-solving experience, while providing communities with working solutions to previously vexing challenges” (Solutions-focused Interactive ‘Ateliers’, 2012 para. 1). The benefit to faculty and students lies in bridging the disciplinary gaps while enhancing the cognitive teaching skills of instructors and the cognitive learning skills of students. Transforming the traditional classroom with activities that interest and engage students can improve the cognitive levels of learning.

**Class size**

Data support the premise that levels of class participation are higher when the average class size is smaller (Tsui, 2002). Observations conducted within these four case studies indicated greater participation in the two smaller classes (approximately 20 students) and an increase in the average number of questions presented by the instructors. Smaller classes foster stronger bonds through class projects and in peer-to-peer networking for group work, homework, and outside class assignments (Astin 1993) and a 1990 study (Finn & Achilles) found that significant benefits accrued to students in smaller classes based on assessment scores.

It is understandable that universities would desire larger classes from an economic perspective, but larger classes often make it impractical to incorporate higher order cognitive activities such as group work or to engage students in pertinent discussions. One potential solution would be to mirror the process of one of the undergraduate courses at Arizona State University. This class met twice during the week with one session dedicated to lecture and the other focused on small group projects. Interactive community projects can also engage large class populations by segmenting the work into small groups with varying activities.
These can be assigned assessments outside of regular class hours and conducted at various times during the week to accommodate schedules.

**Instructor strategies**

Deficiencies in instructional methods that develop higher order thinking within postsecondary settings can be aided by integrating non-traditional methods of teaching with a focus on positively correlated assessments (Burns, 2011; Allen-Gil et al., 2008; Tsui, 1999). Traditional curriculum and instruction methods have demonstrated their limitations in sustainability education, as every environmental indicator has deteriorated in the past 30 years (Cook, Cutting, and Summers, 2010). In addition to the non-traditional group work noted previously, using specific assessment methods can enhance cognitive thinking skills. It is recommended that instructors write assessments which include having an essay critiqued by an instructor, conducting independent research, working on a group project, giving a class presentation, and taking essay exams (Tsui, 2001; Astin, 1993).

**Recommendations for Future Research**

One of the limitations of this study was the assimilation of data collected from undergraduate and graduate degree programs rather than analyzing these data separately. Notable differences that justify stratifying the populations include the size of classes (larger classes in undergraduate courses), the structure of the courses (undergraduate classes involved more instructor discourse), apparent ages of the participants (a visual inventory suggested that the majority of the undergraduate students were younger), and less interaction in both peer-to-peer and student-instructor engagements in the undergraduate courses. Future research should focus on the comparisons of these differences rather than integrating the undergraduate and graduate data.
Longitudinal studies of sustainability courses could also be conducted to gain a better understanding of student progress during the semester. Analysis of the class instruction could be explored by conducting data collection during the early weeks of class and periodically throughout the semester. This could address the question of whether higher order cognitive levels vary along a timeline from the beginning of a semester to the end.

Future research is also needed to identify, inventory, and assess the disciplinary nature of these programs to determine if educational course offerings are transdisciplinary or focus within specific fields of study. Program offerings within the sample frame indicated a diverse range of pursuits for individuals seeking sustainability-based education. These included both graduate and undergraduate sustainability certificates, minors, majors, and degree programs.

Research should include development of an instrument that provides the researcher with an equal opportunity to assess cognitive processes across all levels. A significant number of studies using the Florida Taxonomy of Cognitive Behavior have typically found lower order cognitive skills in instructor discourse. This may indicate an issue with the validity of the instrument rather than the educational processes being measured. Whittington and Newcomb (1993) also recommended further study in this area.

Future research should also assess the growth of higher order levels of cognitive learning in students enrolled in sustainability programs. This study lacked data on student outcomes in reference to achieving these learning skills. The findings for this research suggested that instructor discourse involved higher order levels of instruction during approximately 50% of the class time. Qualitative data also indicated that instructor strategies
employed in classes and course assessments were positively related to higher order learning. However, the scope of this study did not include measuring student outcomes.
REFERENCES


Sherburn, M. & Devlin, A.S. (2004). Academic major, environmental concern, and

10.1007/s10669-007-9046-3.

coursework programs. *International Journal of Sustainability in Higher Education, 7*,
400-413.

and P. James, (Eds.). *Sustainable measures*, Sheffield: Greenleaf Publishing,


Educational Psychology, 69*, 180-190.

http://www.pdx.edu/sustainability/solutions-focused-interactive-ateliers

Springett, D. (2010). Education for sustainability in the business studies curriculum:

Ideological struggles. In Jones, P., Selby, D. & Sterling, S. (Eds.), *Sustainability
education; Perspectives and practice across higher education*. (pp. 75-92). London,
UK: Earthscan.


APPENDIX A. SAMPLE FRAME FOR UNIVERSITY SELECTION

(Center for Sustainability, n.d.)

Master’s Degrees in Sustainability Disciplines

Anaheim University- MBA in Sustainable Management

Located in Anaheim, California and Tokyo, Anaheim University offers an online MBA in Sustainable Management. Focused on leadership, social responsibility and sustainable practices, this online ‘Green MBA’ allows graduates to succeed in a fiscally, socially and environmentally responsible way.

Antioch University- MBA in Organizational and Environmental Sustainability

Located in Keene, New Hampshire, Antioch University offers a MBA in Organizational and Environmental Sustainability. "The Master’s in Business Administration in Organizational and Environmental Sustainability—the Green MBA—reflects Antioch New England’s progressive approach to education and a commitment to empowering leaders who effect positive change."

Aquinas College- Master of Sustainable Business

The Master of Sustainable Business degree at Aquinas College is quite unique, challenging and prepares graduates to take a leadership role inside a variety of organizations that commit to the movement. The Master of Sustainable Business Program courses are offered in an eight-week evening format during the fall, winter, and summer semesters. Aquinas College also offers a Master of Management Degree with a concentration in Sustainable Business.

Arizona State University- School of Sustainability

Arizona State University's innovative Sustainability program was launched in 2006. In addition to a Bachelor and a certificate program, ASU offers a Master of Science and a Master of Arts in Sustainability. "The graduate programs train students for academic, research, and professional roles. Graduates will be able to understand the dynamics of coupled social and environmental systems and will be able to organize collaborative teams to conduct research and provide adaptive solutions to specific sustainability problems."

Bainbridge Graduate Institute

The Institute is located on Bainbridge Island in Washington and it offers an MBA and Certificate in Sustainable Business.

Brandeis University- MBA in Socially Responsible Business

Brandeis University (Waltham, Massachusetts) offers a Master of Arts in Sustainable International Development, a M.B.A with a Concentration in Sustainable Development, and a Master of Science in International Health Policy and Management. The MBA is a 15-month program, while the M.A. includes a Year-in-Residence studying with senior researchers and development practitioners, followed by a year long field project, internship, or advanced study.
Colorado State University- Global Social and Sustainable Enterprise Program

Colorado State University’s Graduate Degree in Global Social and Sustainable Enterprise provides business skills, the experience, the network and the attitude necessary to build and manage sustainable enterprises.

Columbia College- MFA in Interior Architecture & MFA in Architectural Studies

"Beginning in fall, 2007, Columbia College Chicago’s Masters of Fine Arts programs in Architectural Studies and Interior Architecture will be focused on sustainable design, making Columbia among the first schools in the nation to ground its academic architectural design training in sustainable practice."

Dominican University of California- Green MBA program

Dominican University of California is located in the San Francisco Bay area and offers an onsite Green MBA program. Graduates receive a Master of Business Administration Degree in Sustainable Enterprise. Students can choose between a two-year full-time or three-year part-time structure. "Dominican University of California’s MBA in Sustainable Enterprise is an engaging learning community where people with strong environmental and social values develop effective leadership capacities to advance economically successful, ecologically restorative, and socially just initiatives in any type of organization."

Duquesne University- MBA in Sustainability

Located in Pittsburgh, Pennsylvania, Duquesne University offers a MBA in sustainability. "This MBA program is designed for a new generation of leaders who want to enhance organizational competitiveness and profitability while being socially and environmentally responsible. The innovative daytime program features a challenging, internationally-accredited curriculum and practical application of cutting-edge models in real management situations."

Goddard College

Goddard College, a small liberal arts college in rural Vermont, offers a Master of Arts in Socially Responsible Business and Sustainable Communities (MA SRBSC). "The program will be offered in two formats: a two year full-time 48 credit master’s degree program and a one year full-time 24 credit certificate of graduate study program. Both formats will be delivered using Goddard College’s intensive residency graduate education model." Three areas of focus are available, including Socially Responsible Business, Social Entrepreneurship, and Sustainable Communities.

Green Mountain College

"Green Mountain offers an accredited M.B.A. that emphasizes sustainable business practices. Students learn how to achieve their economic objectives while addressing the needs of employees, their community and other stakeholders. Our program reflects the growing trend among successful companies to focus on the triple bottom line, seeking competitive advantages through practices that are socially responsible and environmentally sound."

Indiana University- Graduate concentration in sustainable development
"Students in the Master of Public Affairs degree program at the Indiana University School of Public and Environmental Affairs can now pursue an academic concentration in sustainable development. The option is available to students in the MPA program at IU Bloomington. SPEA faculty members believe it is the first sustainable development concentration offered by a university public affairs program."

**Iowa State University**

Iowa State University offers master and doctoral degrees in Sustainable Agriculture. "The intent of the Graduate Program in Sustainable Agriculture (GPSA) is to develop student competence and expertise in the design, implementation, and evaluation of sustainable agricultural systems."

**Presidio World College**

Presidio World College offers an MBA with a concentration in Sustainable Management. Throughout the two-year, 60 credit hour curriculum, students increasingly move from engaging with who they are as individuals to who they are as cultural beings.

**Slippery Rock University**

Since 1990, SRU has offered a 37-credit hour interdisciplinary Master of Science in Sustainable Systems (MS3) degree. The core curriculum requires courses in sustainability theory, ecology, research, and an internship. The program also provides tracks for sustainable agriculture, sustainable architecture, resource management, and systems.

**Stanford**

Stanford offers a two-year, full-time, residential day MBA program with a variety of sustainable business concepts integrated into the curriculum. In October 2005, Stanford's MBA program was rated the best for sustainable business education by "Beyond Grey Pinstripes 2005".

**University of Malta- M.Sc. in Sustainable Environment Resources Management**

"The M.Sc. in Sustainable Environment Resources Management will enable participants to apply technical knowledge to address complex natural and anthropogenic problems that impact a broad range of environmental issues, with a multi-disciplinary, systems approach. The programme will motivate participants to develop an international perspective that is culturally balanced addressing, in particular, environmental issues and case-studies that are relevant to the Euro-Mediterranean region."

**University of Michigan- Engineering Sustainable Systems**

Launched in the fall of 2007, the Engineering Sustainable Systems dual degree confers a master of science (M.S.) degree from the School of Natural Resources and Environment (SNRE) and a master of science in engineering (M.S.E.) from the College of Engineering (CoE). Global climate change, energy security, ecological degradation, environmental threats to human health and resource scarcity are critical sustainability challenges for the 21st century. Sustainability is based upon the ability to meet societal needs within the context of economical and ecological constraints. This dual degree provides the tools necessary to help meet those needs.
University of Michigan- M.S. in Natural Resources and Environment

The University of Michigan's School of Natural Resources and Environment offers a M.S. in Natural Resources and Environment. The hallmark of the master’s program is its interdisciplinary focus. This focus can be extended even further through the pursuit of a dual degree. A popular option is the three-year M.S./MBA program, administered by the Erb Institute for Global Sustainable Enterprise, a partnership between Natural Resources and Environment and the Ross School of Business.

University of North Carolina (UNC)

UNC offers an MBA with a concentration in Sustainable Enterprise. Courses cover diverse topics ranging from technology and innovation for sustainable enterprise to nonprofit management, workplace diversity, and labor issues.

University of South Florida- Master of Arts in Global Sustainability

“This degree will prepare students to address complex regional, national, and global challenges related to sustainability and the ability to innovate in diverse cultural, geographic, and demographic contexts. The program will allow for the integration of various disciplines such as basic, natural, and social sciences, engineering, health, economics, governance and policy, and issues of diversity.”

University of Wisconsin- Madison- M.S. in conservation biology and sustainable development

Understanding the complex interactions between natural ecosystems and human societies is essential for ecologically sustainable development, which meets the growing needs of humanity while protecting the integrity of nature. The Conservation Biology and Sustainable Development Program promotes this kind of understanding. Its unique interdisciplinary curriculum combines studies of the nature and value of biological diversity with studies of the economic and social dimensions of development.

Graduate Certificates in Sustainability Disciplines

Anaheim University- Certificate in Sustainable Management

Anaheim University offers a Graduate Certificate in Sustainable Management. Students select 3 sustainable management courses from a choice of 4 and the convenient 6 week course format permits program completion in 18 weeks. The Certificate is offered 100% online.
Aquinas College

The Graduate Certificate in Sustainable Business requires a total of 12 credits. Courses include:

Industrial Ecology
Sustainable Business Management
Building Social Capital
Sustainable Business Elective

Certificate in Biomimicry

This two-year certificate program is offered by the Biomimicry Institute, in cooperation with the Biomimicry Guild, and is intended for individuals possessing an undergraduate or more advanced degree. "The program is designed to give attendees the skills necessary to become practicing biomimics. The course will be taught by a suite of experts, led by Dr. Dayna Baumeister, co-founder of the Biomimicry Guild, in the fields of biomimicry and sustainability with several guest lectures by prominent, world-renowned visionaries in the fields of sustainability, green business, green chemistry, ecological design, and more."

Davenport University- Post-Baccalaureate Certificate in Sustainable Business Development

This Post-Baccalaureate Certificate is offered to students that have completed a Bachelor’s Degree and wish to understand and apply sustainable business methods to their career. This 15 credit hour curriculum focuses on educating students of triple-bottom line concepts, international perspectives, leadership, and social responsibility.

Michigan Technological University

The Graduate Certificate in Sustainability requires a total of 15 credits and formally recognizes curricular breadth in the following areas:

Policy, societal, and economic systems
Environmental systems
Industrial systems

Portland State University (PSU)

The PSU Certificate Program in Implementing Sustainability provides the key concepts, tools, and resources you need to start developing your organization’s sustainability program. In the workshops, you will apply key concepts to real-world problems and actual situations in the workplace. The certificate consists of four core courses and two electives.

University of Michigan- Graduate Certificate in Industrial Ecology

The primary objective of the Program in Industrial Ecology (PIE) is to provide University of Michigan graduate students fundamental skills in, and knowledge of, industrial ecology methods and applications. PIE's certificate complements any field of study by providing specialization in technological and industrial innovation, consumer behavior and consumption patterns, policy and regulatory issues, and economic factors and market forces to achieve more sustainable systems. Participating students will be better prepared to design
and manage natural and industrial systems to meet human needs in an environmentally, economically and socially sustainable manner.

University of Southern California

The goal of the Center for Sustainable Cities Graduate Certificate Program is to produce superior scholars prepared for leadership positions in a wide variety of domains: academia, private sector firms, nongovernmental bodies, and public agencies. Students seeking to complete the Sustainable Cities Graduate Certificate Program must be pursuing graduate programs in one of many disciplines: engineering, biology, chemistry, earth sciences, economics, geography, international relations, political science, public policy, sociology, urban planning, and others. They receive a graduate degree in their field, while specializing in urban sustainability problems. (‘Center for Sustainability’, 2011)
### APPENDIX B. FAMILY AND CONSUMER SCIENCES STANDARDS AND COMPETENCIES RELATED TO SUSTAINABILITY

| 2.2 | Analyze the relationship of the environment to family and consumer resources. | 2.2.1 | Analyze individual and family responsibility in relation to the environmental trends and issues. |
| 2.2.2 | Summarize environmental trends and issues affecting families and future generations. |
| 2.2.3 | Demonstrate behaviors that conserve, reuse, and recycle resources to maintain the environment. |
| 2.2.4 | Explain government regulations for conserving natural resources. |

| 3.4 | Analyze resource consumption for conservation and waste management practices | 3.4.1 | Investigate sources and types of residential and commercial energy, water policy and usage, waste disposal, and pollution issues. |
| 3.4.2 | Evaluate local, state, and national private and government consumer programs and services to recycle and conserve energy and environmental resources. |
| 3.4.3 | Explore strategies and practices to conserve energy and reduce waste. |
| 3.4.4 | Examine waste management issues. |
| 3.4.5 | Examine roles of government, industry, and family in energy consumption. |

| 7.4 | Evaluate conditions affecting individuals and families with a variety of disadvantaging conditions. | 7.4.1 | Assess health, wellness, and safety issues of individual and families with a variety of disadvantaging conditions. |
| 7.4.2 | Analyze management and living environment issues of individuals and families with a variety of disadvantaging conditions. |
| 7.4.3 | Analyze personal, social, emotional, economic, vocational, educational, and recreational issues for individuals and family with a variety of disadvantaging conditions. |
| 7.4.4 | Discriminate between situations that require personal prevention or intervention and those situations that require professional assistance. |
| 7.4.5 | Analyze situations which require crisis intervention |
| 7.4.6 | Summarize the appropriate support needed to address selected human services issues. |

National Standards for Family and Consumer Sciences. (n.d.).
APPENDIX C. THE TALLOIRES DECLARATION

10 Point Action Plan

We, the presidents, rectors, and vice chancellors of universities from all regions of the world are deeply concerned about the unprecedented scale and speed of environmental pollution and degradation, and the depletion of natural resources.

Local, regional, and global air and water pollution; accumulation and distribution of toxic wastes; destruction and depletion of forests, soil, and water; depletion of the ozone layer and emission of “green house” gases threaten the survival of humans and thousands of other living species, the integrity of the earth and its biodiversity, the security of nations, and the heritage of future generations. These environmental changes are caused by inequitable and unsustainable production and consumption patterns that aggravate poverty in many regions of the world.

We believe that urgent actions are needed to address these fundamental problems and reverse the trends. Stabilization of human population, adoption of environmentally sound industrial and agricultural technologies, reforestation, and ecological restoration are crucial elements in creating an equitable and sustainable future for all humankind in harmony with nature.

Universities have a major role in the education, research, policy formation, and information exchange necessary to make these goals possible. Thus, university leaders must initiate and support mobilization of internal and external resources so that their institutions respond to this urgent challenge.

We, therefore, agree to take the following actions:

1) Increase Awareness of Environmentally Sustainable Development

Use every opportunity to raise public, government, industry, foundation, and university awareness by openly addressing the urgent need to move toward an environmentally sustainable future.

2) Create an Institutional Culture of Sustainability

Encourage all universities to engage in education, research, policy formation, and information exchange on population, environment, and development to move toward global sustainability.

3) Educate for Environmentally Responsible Citizenship

Establish programs to produce expertise in environmental management, sustainable economic development, population, and related fields to ensure that all university graduates
are environmentally literate and have the awareness and understanding to be ecologically responsible citizens.

4) Foster Environmental Literacy For All

Create programs to develop the capability of university faculty to teach environmental literacy to all undergraduate, graduate, and professional students.

5) Practice Institutional Ecology

Set an example of environmental responsibility by establishing institutional ecology policies and practices of resource conservation, recycling, waste reduction, and environmentally sound operations.

6) Involve All Stakeholders

Encourage involvement of government, foundations, and industry in supporting interdisciplinary research, education, policy formation, and information exchange in environmentally sustainable development. Expand work with community and nongovernmental organizations to assist in finding solutions to environmental problems.

7) Collaborate for Interdisciplinary Approaches

Convene university faculty and administrators with environmental practitioners to develop interdisciplinary approaches to curricula, research initiatives, operations, and outreach activities that support an environmentally sustainable future.

8) Enhance Capacity of Primary and Secondary Schools

Establish partnerships with primary and secondary schools to help develop the capacity for interdisciplinary teaching about population, environment, and sustainable development.

9) Broaden Service and Outreach Nationally and Internationally

Work with national and international organizations to promote a worldwide university effort toward a sustainable future.

10) Maintain the Movement

Establish a Secretariat and a steering committee to continue this momentum, and to inform and support each other’s efforts in carrying out this declaration.

(Adapted from Talloires Declaration, 2001)
APPENDIX D. INTERVIEW QUESTIONS

Qualitative Questions for Sustainability Courses
Wilson Dissertation
January 2012

General Questions

1. How many years have you been teaching?

2. How many years have you been teaching at ____________ University?

3. How many years have you been involved with teaching or programming in sustainability education?

Curriculum Development

4. Did you help with the creation or implementation of the program or perhaps specific courses?

5. Are you aware of and if so could you describe the process of how the university selects the courses for the sustainability program?

6. What role would you as a professor play in writing the syllabi for sustainability courses?
   a. What panel, committee, or individual approves the final version?
   b. How are the course objectives and assessments developed and adopted?
c. Are you allowed to make revisions to your syllabus as you are teaching the classes?

7. How often are the courses rewritten or revised?

8. Does the administration take into account transdisciplinary studies?

Student Attitudes and Assessments

9. How do you encourage interaction between you and your students during class?

10. As part of your assessment methods, do you typically have your students do
   a. Group projects?
   b. Service Learning projects?
   c. Primary Research?
   d. Are these projects effective?

11. Describe the attitudes of students in the sustainability programs and how they differ (if at all) from those of other classes you have taught? (i.e. There is more passion or interest in these types of classes)
12. Do your students participate and interact more in smaller classes than in large classes?

Miscellaneous questions on distractions

13. How do you feel about laptops in your classes?

14. Do you have a cellphone policy for your classes?
### APPENDIX E. FLORIDA TAXONOMY OF COGNITIVE BEHAVIOR SCORE SHEET

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<td>1.1 Knowledge of specifics</td>
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<td>2. Spells</td>
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<td>1.1.3</td>
<td>3. Identifies something by name</td>
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<td>4. Defines the meaning of a term</td>
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<td>5. Gives a specific fact</td>
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<td>7. Recognizes a symbol</td>
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<td>8. Cites a rule</td>
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<td>9. Gives chronological sequence</td>
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<td>1.2.5</td>
<td>10. Gives steps of process, describes method</td>
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<td>12. Names classification system or standard</td>
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<td>13. Names what fits given system or standard</td>
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<td>16. Tells about organization or structure</td>
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<td>1.3.4</td>
<td>17. Recalls name of principle, law or theory</td>
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<td>2.0.1</td>
<td>18. Restate in own words or briefer terms</td>
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<td>2.0.2</td>
<td>19. Gives concrete examples of an abstract idea</td>
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<td>20.</td>
<td>Verbalizes from a graphic representation</td>
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<td>21.</td>
<td>Translates verbalization into graphic form</td>
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<td>22.</td>
<td>Translates figurative statements into literal statements or vice versa</td>
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<td>Translates foreign language to English or vice versa</td>
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<td>24.</td>
<td>Gives reason (tells why)</td>
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<td>25.</td>
<td>Shows similarities, differences</td>
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<td>26.</td>
<td>Summarizes or concludes from observation of evidence</td>
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<td>27.</td>
<td>Shows cause and effect relationship</td>
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<td>28.</td>
<td>Gives analogy, simile, metaphor</td>
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<td>29.</td>
<td>Performs a directed task or process</td>
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<td><strong>4.0 Application</strong></td>
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<td>30.</td>
<td>Applies previous learning to new situations</td>
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<td>31.</td>
<td>Applies principle to new situation</td>
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<td>32.</td>
<td>Applies abstract knowledge in a practical situation</td>
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<td>33.</td>
<td>Identifies, selects and carries out process</td>
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<td><strong>5.0 Analysis</strong></td>
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<td>34.</td>
<td>Distinguishes fact from opinion</td>
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<td>35.</td>
<td>Distinguishes fact from hypothesis</td>
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<td>36.</td>
<td>Distinguishes conclusions from statements which support it</td>
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<td>37.</td>
<td>Points out unstated assumption</td>
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<td>38.</td>
<td>Shows interaction or relation of elements</td>
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<td>39.</td>
<td>Points out particulars to justify conclusions</td>
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<td>40.</td>
<td>Checks hypotheses with given information</td>
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</table>
41. Distinguishes relevant from irrelevant statements
42. Detects error in thinking
43. Infers purpose, point of view, thoughts, feelings
44. Recognizes bias or propaganda

**6.0 Synthesis (Creativity)**
45. Recognizes ideas, materials, processes
46. Produces unique communication, divergent idea
47. Produces a plan, proposed set of operations
48. Designs an apparatus
49. Designs a structure
50. Devises a scheme for classifying information
51. Formulates hypotheses, intelligent guesses
52. Makes deductions from abstract symbols, propositions
53. Draws inductive generalization from specifics

**7.0 Evaluation**
54. Evaluates something from evidence
55. Evaluates something from criteria

## APPENDIX F: BLOOM'S TAXONOMY VERBS

Bloom’s Taxonomy Action Verbs

<table>
<thead>
<tr>
<th>Definitions</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Application</th>
<th>Analysis</th>
<th>Synthesis</th>
<th>Evaluation</th>
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<tbody>
<tr>
<td>Bloom’s Definition</td>
<td>Remember previously learned information.</td>
<td>Demonstrate an understanding of the facts.</td>
<td>Apply knowledge to actual situations.</td>
<td>Break down objects or ideas into simpler parts and find evidence to support generalizations.</td>
<td>Compile component ideas into a new whole or propose alternative solutions.</td>
<td>Make and defend judgments based on internal evidence or external criteria.</td>
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</tbody>
</table>

**Verbs**

- Arrange
- Define
- Describe
- Duplicate
- Identify
- Label
- List
- Match
- Memorize
- Name
- Order
- Outline
- Recognize
- Relate
- Recall
- Repeat
- Reproduce
- Select
- State
- Classify
- Convert
- Defend
- Describe
- Discuss
- Distinguish
- Estimate
- Explain
- Express
- Extend
- Generalized
- Give example(s)
- Identify
- Indicate
- Infer
- Locate
- Paraphrase
- Predict
- Recognize
- Rewrite
- Review
- Select
- Summarize
- Translate
- Apply
- Change
- Choose
- Compute
- Demonstrate
- Discover
- Dramatize
- Employ
- Illustrate
- Interpret
- Manipulate
- Modify
- Operate
- Practice
- Predict
- Prepare
- Produce
- Relate
- Schedule
- Show
- Sketch
- Solve
- Use
- Write
- Analyze
- Appraise
- Breakdown
- Calculate
- Categorize
- Compare
- Contrast
- Criticize
- Diagnose
- Differentiate
- Discriminate
- Distinguish
- Examine
- Experiment
- Identify
- Illustrate
- Infer
- Model
- Outline
- Point out
- Question
- Relate
- Select
- Separate
- Subdivide
- Test
- Arrange
- Assemble
- Categorize
- Collect
- Combine
- Comply
- Compose
- Construct
- Create
- Design
- Develop
- Devise
- Explain
- Formulate
- Generate
- Plan
- Prepare
- Rearrange
- Reconstruct
- Relate
- Reorganize
- Revise
- Rewrite
- Set up
- Summarize
- Synthesize
- Tell
- Write
- Appraise
- Argue
- Assess
- Attach
- Choose
- Compare
- Conclude
- Contrast
- Defend
- Describe
- Discriminate
- Estimate
- Evaluate
- Explain
- Judge
- Justify
- Interpret
- Relate
- Predict
- Rate
- Select
- Summarize
- Support
- Value

(Bloom’s Taxonomy Action Verbs, n.d.)
### APPENDIX G: BLOOM'S REVISED TAXONOMY ACTION VERBS

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<thead>
<tr>
<th>Level 1. Remember</th>
<th>Action Verbs for creating learning outcomes (Bloom's Revised Taxonomy)</th>
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<td>Omit</td>
<td>Recite</td>
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<td>Draw</td>
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<td>Recognize</td>
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<td>Define</td>
<td>Match</td>
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<td>Complete</td>
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<td>Discriminate</td>
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<td>Rearrange</td>
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<tr>
<td>Transform</td>
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Additional information about Bloom's Revised Taxonomy is available here: [http://coe.sdsu.edu/eet/Articles/bloomrev/index.htm](http://coe.sdsu.edu/eet/Articles/bloomrev/index.htm)
APPENDIX H: CHALLENGE AREA COURSE REQUIREMENTS

Introductory Core Courses

ASU 101- SOS

The ASU Experience (1) Students will learn about ASU's mission as the New American University, the importance and benefits of an entrepreneurial approach to problem solving, solutions to sustainability challenges, and the importance of social embeddedness. Additionally, through various course discussions and assignments, students will examine the concept of academic integrity and its potential impact on their future, gain awareness of the value of engaging in research activities, and learn about taking an interdisciplinary perspective. *For New Incoming Freshmen

SOS 110

Sustainable World (3) Lays the groundwork for understanding the fundamental geological, biological, and social processes that gave rise to the world we live in and continue to maintain its viability for human life.

SOS 111

Sustainable Cities (3) Introduces technological, social, and cultural principles and innovations for cities under the notion of sustainability and sustainable development within the global, regional, and local contexts. *Satisfies General Studies - (HU or SB) & G

Challenge Area Courses

SOS 320-328 have the following pre-requisites: Completed SOS 110, and SOS 111 (or PUP 190), with a grade of C or better.

SOS 320

Society and Sustainability (3) Establishes an understanding of the human, social, and cultural dimensions of sustainability from multi- and interdisciplinary perspectives and at a variety of spatial and temporal scales. *Satisfies General Studies - SB

SOS 321

Policy and Governance in Sustainable Systems (3) Explores the wide array of political questions that are raised when we view the Earth's environment as an integrated, global system.
SOS 322

International Development and Sustainability (3) Historical roots of the idea of development; economic theories of growth and their implications for sustainability; interrelationship among population growth, food security, poverty, inequality, urbanization, technological change, international trade, and environmental change at local, regional and global scale.

SOS 323

Sustainable Urban Dynamics (3) Human and physical processes shaping urban ecologies and environments; human-environment interactions in the context of an urban region; effect of the institution and regulatory framework on the ability of social and urban-ecological systems to be resilient and sustainable; urban design, materials, transport, planning, and regulation.

SOS 324

Sustainable Energy, Materials and Technology (3) Sustainable engineering; overall energy needs and impacts; thermodynamics, heat transfer, and fluid mechanisms; atmospheric energy systems; field investigation; current and future urban energy systems.

SOS 325

The Economics of Sustainability (3) Application of economic principles to the allocation of environmental goods and services, external environmental effects, and environmental public goods; decision-making under uncertainty, adaptation to and mitigation of environmental change.

SOS 326

Sustainable Ecosystems (3) How human activities and management practices alter biodiversity, ecosystem functioning, and the provisioning of ecosystem services; use of economic and other social science perspectives to estimate the value of ecosystem services; evaluation of options for achieving the sustainable flow of services from ecosystems.

SOS 327

Sustainable Food and Farms (3) Food systems and sustainability. Theories of food security, rural livelihood sustainability, and food sovereignty. Critically examines the social, ecological, economic, and institutional dimensions of the many sustainability challenges associated with food system activities (production, processing, distribution, consumption, waste). Students develop a food system framework and apply knowledge to an assessment of the sustainability of one aspect of the local food system.
SOS 328

Sustainability and Enterprise (3) The course will examine the evolving interface between sustainability and human enterprise. The class will first explore and review key fundamental concepts in the sustainability arena, including economic and scientific drivers and select historical and structural aspects that create the current context for the enterprise and sustainability interface found today. The class will then delve into more specific case studies of attempts by current businesses to become “greener” and “more sustainable”; exploring challenges and opportunities that are commonly found as well as how decisions are often made in today’s business settings and by whom. Alternative enterprise models and examples of businesses that are using the current context to redefine the sustainability and enterprise interface will be explored and discussed. Given the emergent nature of this effort, timely and real-world examples from current events will be utilized when possible. Finally, participants will explore and apply an integrated approach to sustainability and enterprise. Popular texts, original research articles and current events will make up the basis of course readings.

(Undergraduate Handbook-Bachelor of Arts in Sustainability, 2011).
APPENDIX I. LEADERSHIP FOR SUSTAINABILITY EDUCATION-COURSE DESCRIPTIONS

ELP 550: Advanced Leadership for Sustainability (4)

This multi-media seminar course reviews, analyzes and critiques the history, politics and rhetoric of sustainability. A number of key themes related to leadership for sustainability are addressed: The history and meaning of sustainability; approaches to leadership and strategies and skills used by sustainability leaders; the effects of globalization on humans and ecology; whole systems thinking and design; and the role of eco-spiritual values and Traditional Ecological Knowledge (TEK) in sustainability. Inspiration is drawn from local, regional and global initiatives that are creating sustainable economies, systems, policies, and appropriate technologies. Through reading, discussion and experiential service learning, students will develop their own sustainability vision into action project.

ELP 548: Advanced Global Political Ecology (4)

In order to grasp the emerging discipline of political ecology, we discuss the following: the impact of a globalized economy on human and non-human communities; the relationship between poverty, global inequity and environmental degradation, the distribution of resource use and conflicts between the global North and global South, the ecological processes, earth democracy and the relationship of these issues in our personal lives. Students apply these concepts in real life through a multi-media study and presentation of a chosen commodity in terms of its production, distribution and consumption.

ELP 517/617: Ecological and Cultural Foundations of Learning (4)

This course explores how we teach and learn ecologically and what constitutes ecological and cultural ways of knowing. This course goes beyond simply justifying or advocating that our education should be grounded in ecological principles and explores how teaching and learning can be designed so that it critically questions cultural norms, is place-based, participatory, experiential, and transformational. Building on the work of numerous sustainability educators, this course engages in multi-sensory and interdisciplinary pedagogical inquiry. Students will create a teaching philosophy that reflects an understanding of ecological principles and sustainability pedagogy, and will demonstrate the design and implementation of an effective teaching experience.

ELP 516/616: Collaborative Ethnographic Research Methods (4)

Are there research methods that help us to gain knowledge, skills and worldviews that in turn help create a world that is livable, ecologically sustainable, socially just and bioculturally diverse? This course introduces various approaches to sustainability education research including community-based research, participatory action research, case study research, ethnography, and feminist approaches to research. Students will create an initial research design for a thesis focused on sustainability education, and will produce a literature review to support this design.
ELP 503: LSE Thesis (4+)

Students work individually with their adviser to define, develop and present a thesis that demonstrates a satisfactory level of knowledge and skill related to sustainability education. The thesis is likely to require 4-6 quarters of work before the completion. Students need instructor's permission before enrolling in the course.

ELP 506: LSE COMPS Exam (4)

This course is designed to provide support to students completing their Comprehensive Examination (Paper). The Comprehensive Examination (Comps) is one of two options (the other is Thesis) required for completing the ELP Master’s degree. The four (4) credit ELP 506 Comps course is required for students electing the Comps option. This course will be offered to help students design, write, and present their Comprehensive Paper at the final meeting of the course. Students should have completed a minimum of 35 credits before enrolling in the course.

ELP 519: Sustainability Education (4)

In order to build a robust theory and practice of sustainability education, this course covers local, national and global innovations in light of the UN decade for Education for Sustainability (2005-15). While critically assessing earlier traditions such as nature education, environmental education, outdoor education, place-based education, and ecological literacy; students are involved in developing curriculum and teacher preparation modules for K-12, higher education and or community organizations.

ELP 501: Theory and Practice of Sustainability (1-4)

This course shows the application of theories and models in sustainability design, social justice, and bio-cultural diversity. Through hands-on workshops, personal stories, lectures, and discussion, students experience real life examples of how individuals and institutions have developed a vision and implemented that vision in various areas of sustainability including: Education, Community Leadership and Governance, Food Systems and Policies, Indigenous Practices, and Appropriate Technology. Through group and individual reflection, students explore how they can integrate these experiences and perspectives into their own practice of sustainability education.

ELP 410/510: Permaculture and Whole Systems Design I (4)

Building on the work of permaculture co-originators Bill Mollison and David Holmgren, this course also looks at the more recent development of permaculture ideas. The course presents permaculture as an ethically based whole-systems design that uses concepts, principles, and methods derived from ecosystems, indigenous peoples, and other time-tested systems to create sustainable human settlements and institutions. This course will explore permaculture in-depth while also reviewing the evolution of whole-systems design, and the application of self-organization design.

ELP 410/510: Permaculture and Whole Systems Design II (4)

This course builds upon the knowledge gained in Part I of Permaculture and Whole Systems Design (required prerequisite), and explores in-depth: Methods of whole systems design,
advanced pattern literacy, biomimicry, appropriate technology, energy systems, land use philosophy and practice, and education and teaching methods in permaculture. Much of the course will be presented through experiential learning exercises, group discussion and projects, and hands-on activities. A portion of this course is dedicated to a final design project, in which student teams will create a permaculture design for a specific site.

ELP 410U/510: Spiritual Leadership (4)

This course focuses on various perspectives of religiousness and what is often called the spiritual. We discuss how such notions are integrated with the “whole of living” including what it means to be fully human. The topic of spiritual leadership is explored through such themes such as: identity, integrity, paradox, uncertainty, relationships, engagement, simplicity, and sustainability. A community-based field project complements readings and class discussions to give students an opportunity to examine leadership issues through the lens of spiritual discourse. All projects and readings are designed to create an open inquiry into the question “What is spiritual leadership?”

ELP 410/510: Nonviolence and Gandhi's Educational Philosophy (4)

This course has a two-fold goal: to study the principle of nonviolence as defined by Gandhi and to examine how this principle may be applied in our daily lives, including educational and other work settings. We will explore the links between nonviolence and Gandhi's notions of community, sarvodaya (welfare of all), anekantvada (belief in many doctrines), labor, self-sufficiency, advaita (non-dualism), enoughness, yajna (sacrifice), and non-exploitative modes of living proposed by Gandhi. Throughout the course, we will examine his educational program of nai talim (new education). This course adopts a unique approach to practicing nonviolence and conflict resolution in education. Daily, educators are bombarded with "new" strategies for dealing with conflicts and challenges. While we will search for and develop specific practical approaches to dealing with these challenges, the participants will ask "broader" questions related to what it means to be nonviolent. We will consider the contemporary relevance of Gandhi's nonviolence as a way of living focusing on key facets of Gandhian theory and practice for ecological sustainability.

ELP 410/510: Learning Gardens and Sustainability Education (4)

By now, many of us are familiar with the themes of "sustainability" and "sustainability education;" in fact, living and studying in the Northwest, it would be most surprising if our psyche were not shaped by concerns about the environment. What is not clear is whether we, as educators, community organizers, designers, and activists, know precisely how to devise curriculum, teach, learn, or prepare educators and leaders who could create a world that is livable, ecologically sustainable, bio-culturally diverse, and socially just. As the field of sustainability education is new and wide-open, this course will use the Learning Gardens framework to break new grounds for sustainability education.

ELP 410/510: Garden-Based Education Research (4)

This is an on-line course. Students interested in doing a literature review of the research on Garden Based Education and synthesizing the research around themes such as: food and nutrition, academic performance, health, social development, motivation and engagement, etc., are encouraged to sign up for the course.
ELP 510: Urban Education Farm: Food Policy, Curriculum Design, and Action! (1-4)
This course offers a facilitated learning experience in the theory and practice of developing and implementing theoretically-based, behaviorally driven curriculum for garden-based learning experiences that are tied to the Oregon state benchmarks. This course also develops standardized menu of garden-based learning curriculum that has been pilot tested for teachers and garden coordinators to choose from the Learning Gardens Project and the needs of individual students.

ELP 410/510: LECL Naturalist Mentoring (2-4)
This course offers cutting-edge multi-sensory participation in our embodied ecosystems through which one learns the language of the more than human world by practicing arts, sciences, and crafts rooted in sustainable earth based cultures. Students are engaged in restoring the bond between people and the natural world in order to foster our sense of place and embrace this earth as our own home. This course returns to those hunting gathering roots of awareness and learning tested and refined through thousands of years of human survival.

ELP 510: Ecological Education in K-8 School (4)
Designed for the purpose of professional development for practicing K-12 principals and educators, this course researches principles of ecological education in K-8 schools through readings, class discussions, field study/observations, and curriculum development. In collaborative teams, participants revise, and revisit existing curriculum modules as well as develop curriculum to be used in K-12 classrooms.

(LSE course descriptions, 2012)
APPENDIX J: IRB APPROVAL

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Date: 9/19/2011
To: Dennis L. Wilson
1242 Cork Dr
Papillion, NE 68046

CC: Dr. Robert Bosselman
31 MacKay

From: Office for Responsible Research

Title: Assessing Cognitive Instruction, Transdisciplinary Domains, and Attitude Toward Higher Cognitive Levels of Instruction in Graduate Sustainability Programs

IRB Log #: 11-411

Study Review 9/16/2011

The project referenced above has been declared exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b).

The determination of exemption means that:

- You do not need to submit an application for annual continuing review.

- You must carry out the research as described in the IRB application. Review by IRB staff is required prior to implementing modifications that may change the exempt status of the research. In general, review is required for any modifications to the research procedures (e.g., method of data collection, nature or scope of information to be collected, changes in confidentiality measures, etc.), modifications that result in the inclusion of participants from vulnerable populations, and/or any change that may increase the risk or discomfort to participants. Changes to key personnel must also be approved. The purpose of review is to determine if the project still meets the federal criteria for exemption.

Non-exempt research is subject to many regulatory requirements that must be addressed prior to implementation of the study. Conducting non-exempt research without IRB review and approval may constitute non-compliance with federal regulations and/or academic misconduct according to ISU policy.

Detailed information about requirements for submission of modifications can be found on the Exempt Study Modification Form. A Personnel Change Form may be submitted when the only modification involves changes in study staff. If it is determined that exemption is no longer warranted, then an Application for Approval of Research Involving Humans Form will need to be submitted and approved before proceeding with data collection.

Please note that you must submit all research involving human participants for review. Only the IRB or designees may make the determination of exemption, even if you conduct a study in the future that is exactly like this study.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.
APPENDIX K: INFORMED CONSENT FORM

INFORMED CONSENT DOCUMENT

Assessing Cognitive Instruction, Transdisciplinary Domains, and Attitude Toward Higher Cognitive Levels of Instruction in Graduate Sustainability Programs

This form describes a research project and contains information to help you decide whether or not to participate. Please take your time in deciding if you would like to take part and understand that your participation is completely voluntary. Please feel free to ask questions at any time.

Investigators: Dennis L. Wilson, a PhD student at Iowa State University will be conducting the research as part of the requirements for the degree of Doctor of Philosophy in Family and Consumer Sciences Education.

INTRODUCTION

Sustainability education has developed from a topic in classroom discussions to certificates and degree programs taught within sustainability institutes at major universities in the U.S. One of the major arguments and features of these sustainability programs has been the need to teach at higher levels of education in a transdisciplinary (aka interdisciplinary) environment of social, economic, and environmental areas of study. The purpose of this study is to assess the level of teaching at three university programs and to assess the transdisciplinary nature of these programs at the graduate level of study. The research will further examine the relationship of the instructor’s attitude toward teaching at higher levels compared to the assessed level of teaching.

You are being invited to participate in this study because you are an instructor teaching a graduate level course in sustainability education at one of the three universities being studied; Arizona State University, Northern Arizona University, or Portland State University. You should not participate if you do not meet these criteria.

DESCRIPTION OF PROCEDURES

If you agree to participate, you will be asked to allow Dennis Wilson to collect data within your classroom and to allow him to review your class syllabus or syllabi. The method of collection will be the Florida Taxonomy of Cognitive Behavior (FTCB). The process involves the researcher sitting in the classroom and checking off action words used during class lectures, activities, discussion, and other instructor-student interactions. You will also be asked to complete a 50-question survey which will assess your attitude toward teaching at higher levels of education. This survey will be mailed or emailed to you and self-administered. It will use a 5-point Likert scale and should take 20 to 30 minutes to complete. Each class and program will be evaluated for its social, economic, and environmental content.
You may also be asked if the class could be videotaped to assist in the data collection, however this will be completely voluntary and subject to university policies. The tape would be viewed only by the researcher and only for the purposes of verifying the data.

Data will be collected during three separate classes for each instructor in the sample. All data collection will planned for collection during the fall semester or trimester of 2011. However, if schedules for the instructors, the researcher, or the IRB for each university cannot be accommodated, other arrangements will be made for data collection in the spring semester or trimester of 2012. Your participation will last through the third class of the data collection.

RISKS
Participants for this study will not be identified and the study should pose no foreseeable risk to the instructors.

BENEFITS
If you decide to participate in this study, the information collected for your class will be shared with you to aid you in assessing the level at which you teach. It is hoped that the information gained in this study will benefit society by providing an indication of the transdisciplinary nature of sustainability education as well as the cognitive level of teaching. This knowledge could aid instructors in improving classes by adapting coursework to teaching at higher levels.

COSTS AND COMPENSATION
You will not have any costs from participating in this study. You will not be compensated for participating in this study.

PARTICIPANT RIGHTS
Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled. You may also skip any questions in the survey that you do not wish to answer.

CONFIDENTIALITY
Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies, auditing departments of Iowa State University, and the Institutional Review Board (a committee that reviews and approves human subject research
studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information.

To ensure confidentiality to the extent permitted by law, the following measures will be taken: Participants will be assigned a coded number that is known only to the primary investigator (Dennis Wilson). Information regarding the universities will be provided, however there will be no way to identify the individual instructors who participate in the study. Information will be kept on one computer with one back up file (both encrypted) during the data collection, analysis, and writing of the dissertation. The collected data will be retained as required by the regulations and policies of Iowa State University. Otherwise no records will be retained. If the results are published, your identity will remain confidential.

QUESTIONS OR PROBLEMS
You are encouraged to ask questions at any time during this study.

- For further information about the study contact Dennis Wilson at dlwilson@iastate.edu or 402 679-3333. The major professor may also be contacted for questions or information as noted below:
  Dr. Robert Bosselman, Iowa State University
  Professor and Chair; Apparel, Educational Studies, and Hospitality Management
  Office: 31 Mackay
  Phone number: +1 515 294 7474
  Email: drbob@iastate.edu

- If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator, (515) 294-4566, IRB@iastate.edu, or Director, (515) 294-3115, Office for Responsible Research, Iowa State University, Ames, Iowa 50011.

***************************************************************************
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PARTICIPANT SIGNATURE
Your signature indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document, and that your questions have been satisfactorily answered. You will receive a copy of the written informed consent prior to your participation in the study.

Participant’s Name (printed) ___________________________________________

(Participant’s Signature) ______________________________ (Date)
**APPENDIX L: EWING TABLE 4.1: MEAN PERCENTAGES BY COGNITIVE LEVEL FOR CLASSROOM BEHAVIOR**

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</tbody>
</table>

Note: Possible Range for Total Cognitive Weighted Score for Professor Discourse = 10 – 50.

Table 4.1: Total Cognitive Weighted Score for Professor Discourse as Measured by the Florida Taxonomy of Cognitive Behavior by Class Session.

(Ewing, 2006)